Promoting Small-Scale Innovations to Meet the Energy Needs of the Poor Focusing on Developing Countries in South East Asia

by

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Note: The opinions and recommendations expressed in this paper are solely those of the author and do not reflect the views of the International Development Research Centre (IDRC).

Table of Contents

1. Executive Summary

This paper presents an overview of key issues relating to small-scale energy innovation with a particular focus on the situation in five developing countries in Southeast Asia – Cambodia, Indonesia, Lao PDR, the Philippines and Vietnam.

It begins by underlining the importance of energy to human development and presents a snapshot of energy poverty by region. Using lack of access to electricity as a proxy for energy poverty, after Sub-Saharan Africa and South Asia, ASEAN is the region with the third highest level of energy poverty with only 72% of its total population and 55% of its rural population having access to electricity.

Another related indicator of energy poverty is the prevalence of traditional fuels used as energy in cooking. While cumulatively 117m people in the five focus countries of this study are without access to electricity, 244m people, which accounts for 58% of the total population of these countries, still use traditional fuels for cooking, with their attendant negative health, productivity and environmental impacts.

Cooking is by far the largest household energy need for rural households in developing countries. Apart from cooking, basic household energy needs are relatively modest and estimated between 30-60kWh/month. While this consumption is modest, this is sufficient to power lighting, significantly extending hours available for productive use and/or educational purposes, as well as power information and communication technologies, essential tools for information and connection.

Given the large number of people currently without access to electricity, universal grid connection is likely decades away and may indeed not be an optimal goal given cost and environmental considerations. Distributed power generation is a more realistic short term solution and attractive for its lower capital intensiveness, scalability, autonomous operation possibilities, greater potential to utilize locally available resources for power generation as well ability to provide energy at times and levels more suitable to rural consumers.

While technologies with the greatest potential will vary with the specific local context, and indeed an approach using a mix of technologies may often be the best solution, in terms of low cost technologies at a off-grid and micro-grid scale[1], biogas, biomass, hydro and wind appear the lower cost options and are indeed all lower cost compared to diesel generators at the same scale.

[1] 'Off-grid' and 'micro-grid' scales are defined in ESMAP (2007) as energy sources of less than 5kW and less than 500kW respectively.

Across the 5 countries of this study, case studies of rural energy initiatives covering each of these technologies were explored. The case studies encompassed efforts that did appear to reach some reasonable level of scale and sustainability[2], as well as others that were not able to achieve this. The types of local innovation that occurred within these case studies encompassed a variety of innovations. Innovations were typically less technological breakthroughs, but more often local adaptations of technology to better fit the context and materials available. Besides technological adaptation, much of the innovation was innovation around institutional arrangements and new collaborative models, particularly around public-private partnerships. Also important were the financial innovations that took place to provide appropriate financial mechanisms, and while no specific case of policy innovation was discussed, policy innovation can potentially play a key role. Broadly speaking, it was this set of social innovations[3] that really propelled the achievement of scale and sustainability.

The most successful efforts in terms of achieving scale included household level biogas efforts in Vietnam and Cambodia where 27,000 biogas plants were installed in Vietnam by 2007 and 6,000 plants were installed in Cambodia. In both instances microfinance arrangements were made to enable manageable repayment options for poor rural consumers. Another successful effort was the dissemination of improved cookstoves in Cambodia, which now has 130,000 households currently using the stove. Joining this group of success stories is the installation of 8,000 solar home systems by a Laotian social enterprise.

Initiatives that have not yet achieved scale but show considerable promise include a pico hydro capacity building effort in Laos. There is a vibrant local market already existing for pico hydro but a local non-profit is intervening to raise the quality of service provision by local entrepreneurs. Another case study of a commercial SME scale biomass effort in Cambodia also demonstrates considerable potential but is currently challenged to penetrate a market unfamiliar with biomass gasification technology. Another area of potential is that of small wind power in Vietnam where the economics of wind power provision provide a strong business case. However a strong local player has not yet emerged to successfully promulgate the technology.

Finally, initiatives that appear less promising in terms of their ability to achieve scale and sustainability include a number of solar PV efforts, notably a World Bank/GEF funded project in Indonesia in the late 1990s. A social enterprise effort in Vietnam also

[2] This refers not to full financial sustainability but sustainability in the simple sense of prolonged implementation. It is this definition of sustainability that will be applied throughout the paper unless otherwise noted.

[3] The definition of 'social innovation' used in this paper is broad and is defined as the implementation of new ways of doing things that create social value and address social needs. 'Social innovation' encompasses institutional, financial, policy and other forms of innovation, with microfinance, for example, considered a form of social innovation.

struggled, and there is a new solar PV project recently begun in Philippines that is yet unproven but the high level of subsidy involved in the latter appears to limit its prolonged sustainability. For this same reason a number of micro-hydro efforts would appear to have limited scope beyond the life of particular projects, and lastly a wind-powered water pump effort appeared not to have had any intention to achieve impact beyond a once off experiment.

A number of elements were identified as key factors determining the likely success or failure of the various efforts. These are:

A strong institutional framework – This would include one or more key local innovation actors as a leadership organization that could adapt lessons learned to local conditions. In addition, a local champion that lends credibility to new activities is also important. One further identifying feature of a strong institutional framework is some form of public-private partnership. Three of the most successful efforts involved collaboration with various government ministries. With the fourth of the most successful efforts, while the case study reported was not a public-private partnership, subsequently the organisation was involved in a sizeable government project and now firmly believes that public-private partnerships are the key way forward in the rural energy services delivery arena.

An appropriate financial mechanism – In order for poor populations to make worthwhile investments, having an appropriate financial mechanism in place is critical. Appropriate and affordable technologies for rural energy provision in many instances have capital costs in the $200-500 range. Where capital costs were sizeable, all of the more successful case studies had manageable financing arrangements in place, either in the form of microfinance, leasing arrangements or some other financial mechanism that enabled modest payments over an extended period.

Enabling policy aspects – In virtually all of the initiatives that achieved some level of scale, the government played an active role. In many instances Ministries were directly involved the implementation of projects. In other cases there was a supportive policy environment that included permitting the provision of energy by private providers and allowing excess energy from a project to be sold back to the national grid.

Functioning codes of practice – Poor rural communities are risk averse and will adopt new technologies generally based on trust and word-of-mouth marketing. To build this trust to motivate a generally sizeable household investment, maintaining high quality and service standards is key. Providing training for local providers to meet consistent quality standards was a focus for all of the initiatives that achieved scale and is a continuing challenge.

Active involvement of the private sector – In all cases achieving scale, the involvement of the private sector, particularly local craftspeople and SMEs, and the development of a network of supporting small-scale businesses, was responsible for the sustained and sustainable delivery of needed services. Only when market conditions are such that businesses can generate the profits needed to survive in order to participate over a sustained period in the rural energy value chain, can efforts towards the delivery of rural energy services persist and achieve scale and reach. Subsidized efforts can be used to seed new service delivery, and there can situations where continued subsidy makes sense, but the bedrock of scaled, sustainable small-scale rural services delivery rests with decentralized, small-scale private sector players.

Overall, achieving scale and sustainability was not dependent on the type of rural energy technology employed. In the case studies covered, a variety of technologies did achieve scale and have the potential to achieve scale, and those same technologies also failed to achieve scale in other cases. The differentiating elements lie with the five factors identified above and the local innovation, technological as well as particularly social innovation that enabled the sustained take up of rural energy services in several instances. Further explorations in these areas will bear fruitful learnings for funders, policymakers and practitioners. Specific recommendations for further work that could be supported IDRC's Innovation, Technology and Society program initiative are listed in the Recommendations section at the end of this paper.

2. Introduction

The role of energy in development is arguably underappreciated. While energy indicators are not explicitly included in the Millennium Development Goals (MDGs), energy is needed to meet many MDG objectives, and the International Energy Agency (IEA) has called for electricity sector investments of $16B annually over next 10 years[4] to help reach the MDG of halving poverty. Energy poverty limits human capacity development, productivity and economic growth, and exacerbates health and environmental problems.

Besides enhancing the quality of life, lighting is needed to extend productive hours available for labour as well as give children, and adults, opportunities to read and study and enhance their human capital. Modern information and communication technologies, powered by electricity, enable people to educate themselves and provide access to information that can enhance their lives. Energy is needed to provide access to clean water and power irrigation as well as contribute to mechanical power to enhance productivity. Refrigeration can assist to preserve the integrity of medicines

[4] ESMAP (2007) refers to IEA (2004).

and vaccines as well as the preservation of foodstuffs. Cleaner energy technologies can enhance environmental sustainability at local, national and global levels, and less labour intensive energy technologies can redirect human capacity to more productive uses than the gathering of traditional biomass. Improved cooking fuels and methods will reduce indoor air pollution, a major health risk for many of the poor still using traditional biomass cooking methods, particularly women and children.

Addressing energy poverty is a challenge being addressed by significant international efforts, both in terms of grid-based power provision as well as off-grid approaches. As climate change increasingly becomes a global priority, and with the close linkage of energy with climate impacts, addressing the energy needs of a developing world is balanced also with the need to minimize adverse climate impacts, with low carbon approaches utilizing renewable energy technologies soliciting particular interest.

Every country is working to increase its grid-based electricity access, however the particular focus of this study will be looking at smaller scale and nearer-term energy solutions at the village and household levels. National grid-based approaches to meeting energy needs for most of the rural poor are many years away. Even amongst electrified populations in the developing world, much of their energy needs are not met by electricity. Small-scale off-grid and mini-grid approaches to meeting the electricity needs of the rural poor show much promise. As well, a variety of other technological options such as biogas, improved cooking stoves and solar lighting also have the potential to improve the lives and livelihoods of the poor. Some of these technologies have been experimented with for at least a decade. What have been the learnings from attempts to promote such technologies in the past, what are the innovations needed to scale up such efforts in the future?

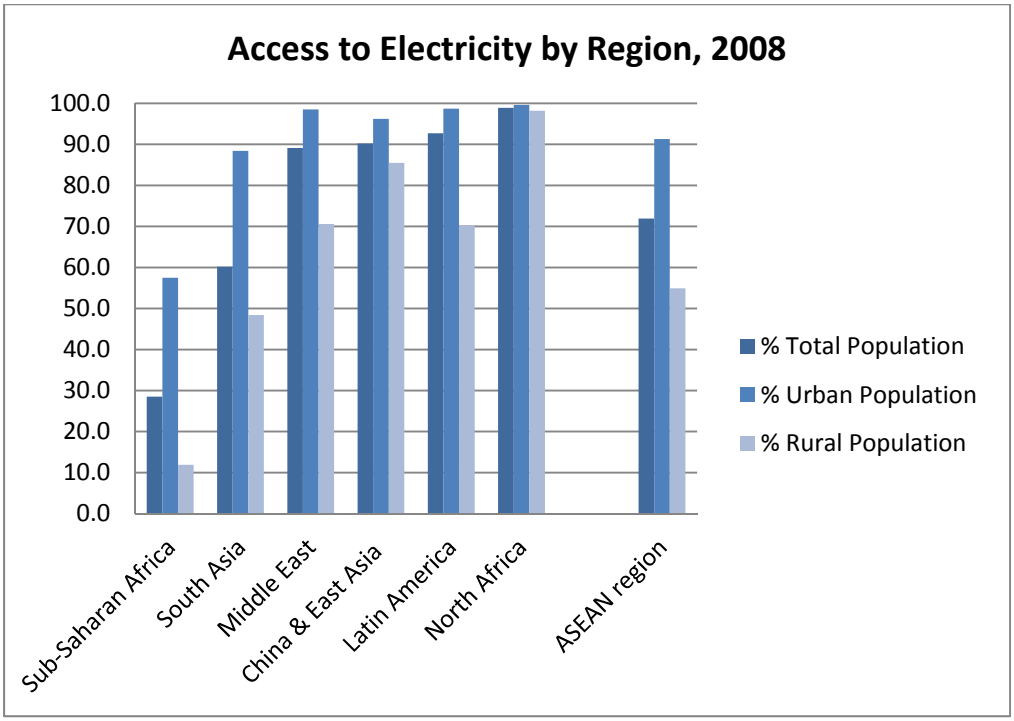
This study will focus on five developing South East Asian countries – Cambodia, Indonesia, Laos, Philippines and Vietnam – with sizeable rural populations that face the challenge of energy poverty amongst its poor. In this variety of national contexts, a number of efforts have been made to provide energy at the household and village level. This study will seek to understand the mosaic of efforts that cover a variety of different technologies. The interest is in understanding how such experiments were initiated, implemented, sustained and, if it occurred, scaled up, what technological, institutional and financial innovations took place, and what supporting mechanisms, policy or institutional frameworks were important in enabling that innovation. Finally, this paper proposes promising areas of pursuit for IDRC's Innovation, Technology and Society Program.

3. Background

While the lack of access to electricity is not the same as energy poverty, access to electricity is a very good indicator of energy poverty. Grid-delivered energy is still generally the lowest cost energy available, and those without grid access will at the very least need to source energy from a variety of less efficient sources typically costing both time and resources.

While strides have been made to increase access to electricity around the world, currently 1.5B people are without access to electricity.[5] As to be expected, it is rural populations that are largely excluded from access.

Figure 1 – Global Overview of Access to Electricity in the Developing World



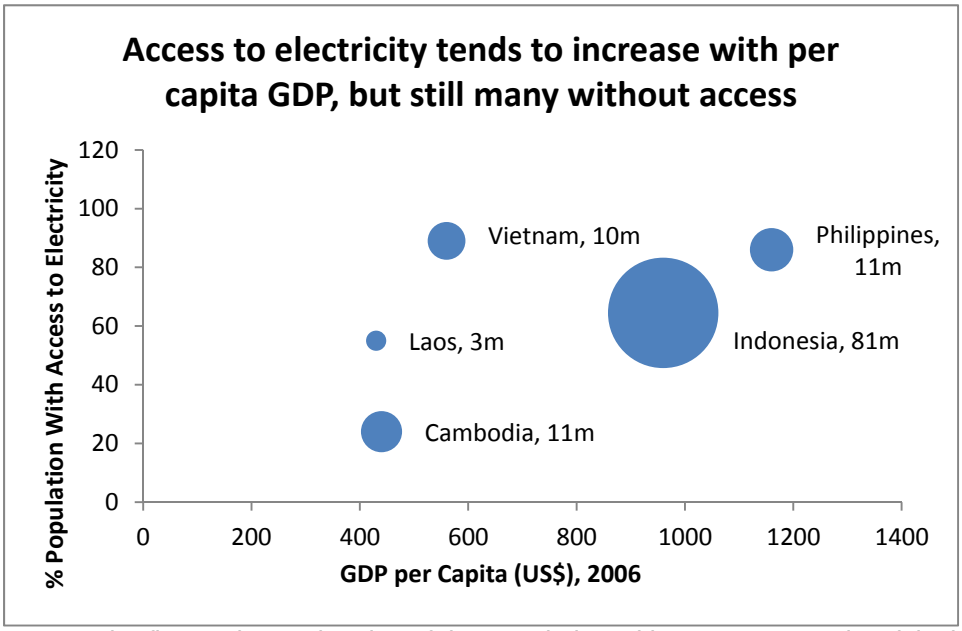
Globally only 63% of rural populations have access to electricity compared to 93% of urban populations. Sub-Saharan Africa is the region most deprived of access to electricity with only 29% of its total population and a mere 12% of its rural population having access, followed by South Asia, where 60% of its total population and 48% of its rural population has access. China and East Asia[6] figures are encouraging at first

[5] Data for 2008, from http://www.iea.org/weo/database_electricity/electricity_access_database.htm.

[6] The IEA definition of China and East Asia above is for a subset of countries in what the IEA terms "Developing Asia". It includes the following countries: China, Brunei, Cambodia, Chinese Taipei, DPR Korea, East Timor,

glance, with purportedly 90% of its total population and 86% of its rural population having access to electricity. However, figures on access in China count village access to electricity as access for the entire population of that village and can be misleading as China claims that 99% of its rural population has access to electricity.[7] Given its large population base, the China statistics dominate these regional figures. For the sub-set of ASEAN (the Association for Southeast Asian Nations) countries, 72% of its total population and only 55% of the rural population has access to electricity. This places ASEAN as the third most electricity deprived regional grouping.[8]

Figure 2 - Access to Electricity and Per Capita GDP for 5 Countries of Interest



Note: In the figure above, the size of the population without access to electricity is depicted by the bubble size, and quantified in figures.

Source: Per cap GDP and population, ADB (2009a); access to electricity UNDP/WHO (2009)

In the countries of concern in this study, rural access to electricity is particularly limited in Cambodia, where only 24% of the total population has access to electricity. While Lao PDR has a similar level of GDP per capita as Cambodia, a considerably greater

Indonesia, Malaysia, Mongolia, Myanmar, PDR Laos, Philippines, Singapore, Thailand, Vietnam and a category labeled "Other Asia" that cumulatively accounts for a population of 42.8m.

[7] In an interesting paper Min (2008) uses satellite imagery of night time lights to generate unbiased estimates of electrification. By this analysis China and India demonstrate very similar levels of electrification, in stark contrast to the difference in their official statistics on electricity access. In 2008, 64.5% of India's population was purported to have access to electricity as opposed to 99.4% of China's population (UNDP/WHO (2009)).

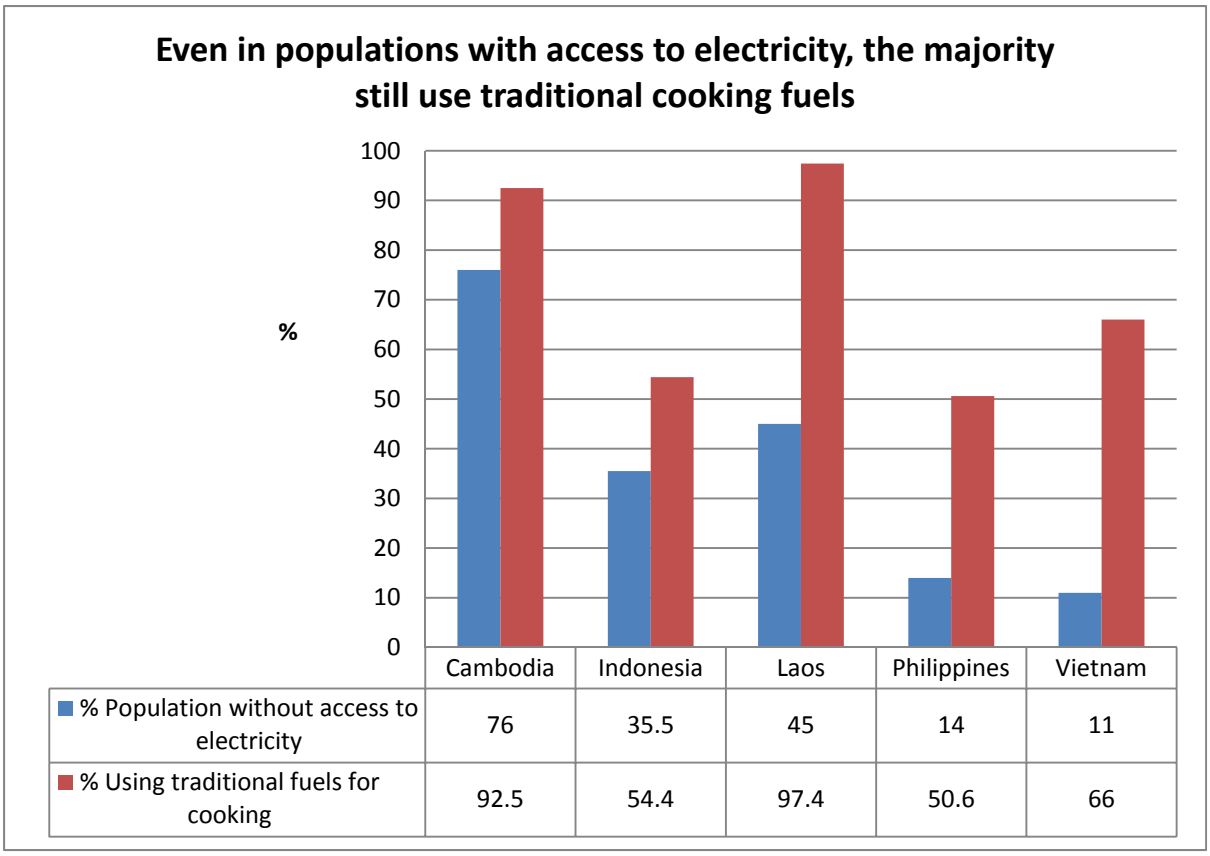
[8] Data for 2008, from http://www.iea.org/weo/database_electricity/electricity_access_database.htm.

proportion of its population, 55%, has electricity access. Vietnam boasts the highest level of electrification amongst the group of countries with 89% of its population with access, likely in part due to fewer geographical challenges for grid-based access. Indonesia's level of access is 64% and has by far the largest population without access, and the Philippines has the second highest level of electricity access at 86%. Even in countries where access is relatively high, having access to electricity does not by any means imply that energy needs are optimally met.

Electricity is appropriate for some household uses, but as the continued prevalence of the use of traditional biomass for cooking highlights, alternative sources of energy that will reduce the use of traditional biomass are also needed. Globally it is estimated that 3B people still rely on traditional biomass for cooking, despite many of these people having access to electricity[9]. In all of the countries under study, the majority of the population still relies on traditional biomass for cooking and the use of wood continues to be prevalent. Not only does this suggest significant climate impacts, there are also considerable costs in terms of time spent, usually by women and children, to gather fuel. In addition there are significant health risks associated with the use of traditional biomass with nearly 2m deaths per year attributable to indoor air pollution from solid fuel use globally.[10] The use of wood fuel also puts considerable pressure on natural resources and typically leads to loss of forests, green cover and can also result in soil degradation.

[9] UNDP/WHO (2009).
[10] Ibid.

Figure 3 – Fuels Used for Cooking

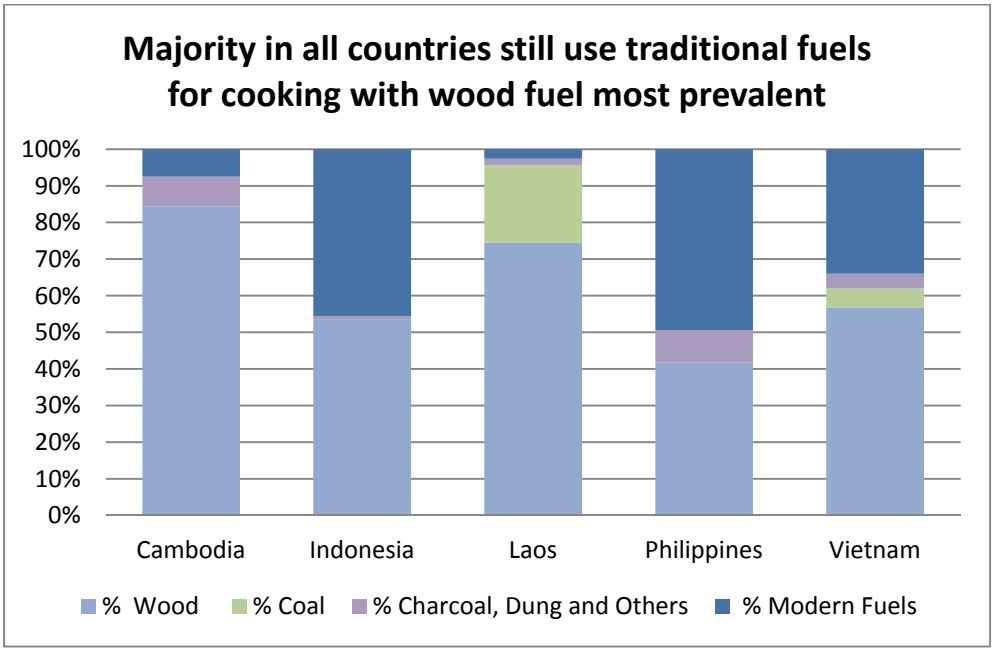


	Cambodia	Indonesia	Laos	Philippines	Vietnam
% Population without access to electricity	76	35.5	45	14	11
% Using traditional fuels for cooking	92.5	54.4	97.4	50.6	66

Source: UNDP/WHO (2009). Note that data above applies to different years but the range is limited to 2003-2007. See original source for specific years for each country.

In the five countries of interest, while 117m are without access to electricity, more than twice that number, 244m, still use solid fuels for cooking. This accounts for 58% of the population of these countries. Solid fuels include traditional biomass (wood, charcoal and dung and others) and coal, while modern fuels refer to electricity, liquid fuels and gaseous fuels such as LPG, natural gas and kerosene. Of traditional fuels, wood is the most commonly used, accounting for between 42% to 84% of fuel used in the five countries in this study.

Figure 4 – Breakdown of cooking fuels by type



Source: UNDP/WHO (2009). Note that data above applies to different years but the range is limited to 2003-2007. See original source for specific years for each country.

4. Energy use at the household level

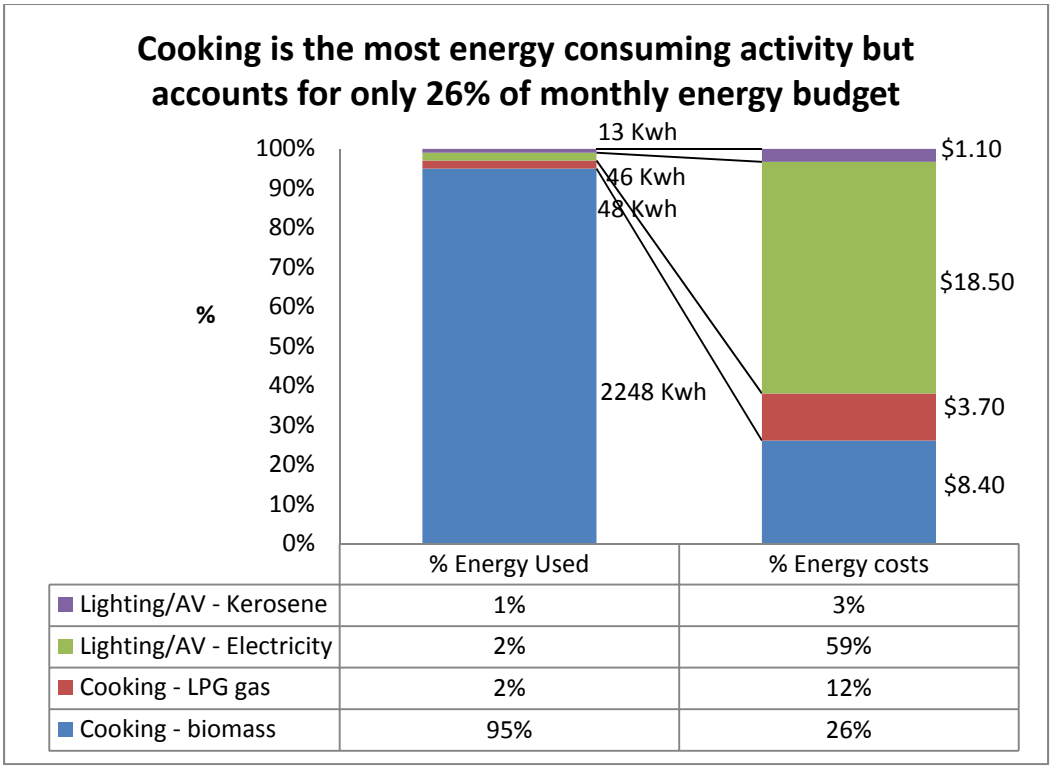
It has been estimated that the poorest households spend as much as 30% of their budget on energy.[11] Poor families in the Asia Pacific region follow this approximated norm and have been estimated to spend 28% of household expenditure on fuels, electricity and transportation.[12]

Cooking is one of the highest use needs for energy in rural households. Apart from cooking, rural household consumption of power is relatively modest. A study by GERES (Groupe Energies Renouvelables, Environnement et Solidarités (Renewable Energies, Environment and Solidarity Group)) in 2008 collected data on energy consumption patterns of households in rural Cambodia. While rural communities around the world will vary in their energy use and expenditure pattern, this does give some sense of scale of the general pattern of energy priorities and costs typical of many poor rural households in developing countries.

[11] GERES (2008), p. 20.
[12] UNDP (2007).

According to the findings of the GERES study presented below, for a rural household in Cambodia, cooking accounts for most of the energy consumption of the household (97.5 %) but less than 38% of the spending on energy. While electricity accounts for only 2% of the energy consumed, it takes up 59% of the energy budget and is often purchased in the form of batteries at a per kWh cost of possibly 50-100 times the cost of grid-delivered electricity.

Figure 5 – Energy Use and Cost for A Rural Cambodian Household



Source: GERES (2008)

The Cambodian data above suggests monthly energy use for non-cooking purposes at about 60kWh. A simple estimation of possible household energy use apart from cooking would yield a similar figure of 30-55 kWh/month.

Table 1: Estimated basic household energy needs

Household Uses	**Monthly Energy Required**
Two 40-60w incandescent lights, 5 hrs/day Radio and small fan for 10 hrs/day TV for 6 hrs/day	10-20 kWh 10-15 kWh 10 kWh

From the research findings and simple energy approximations above, while much of a rural household's energy use is for cooking, despite high costs, rural households also appear to need electricity and are willing to pay for it. Even access to a modest amount of electricity would appear to be highly desired by rural households.

5. Overview of rural energy options

While all countries are working to increase the level of electrification, there are many practical and economic constraints to increased grid access and it will not be a reality in many places for many years, and indeed in some locations grid access may never make sense. Grid extension is expensive, and having electricity available 100% of the time and able to accommodate high peaks but low average consumption would be costly and technically challenging.[13] For dispersed rural consumers, distributed power generation technologies are attractive for many reasons. Their low density and low consumption are well-matched to scalability and autonomous operation possibilities. This type of supply can better able provide energy at times and levels more suitable to rural customers, and also for context-specific purposes.

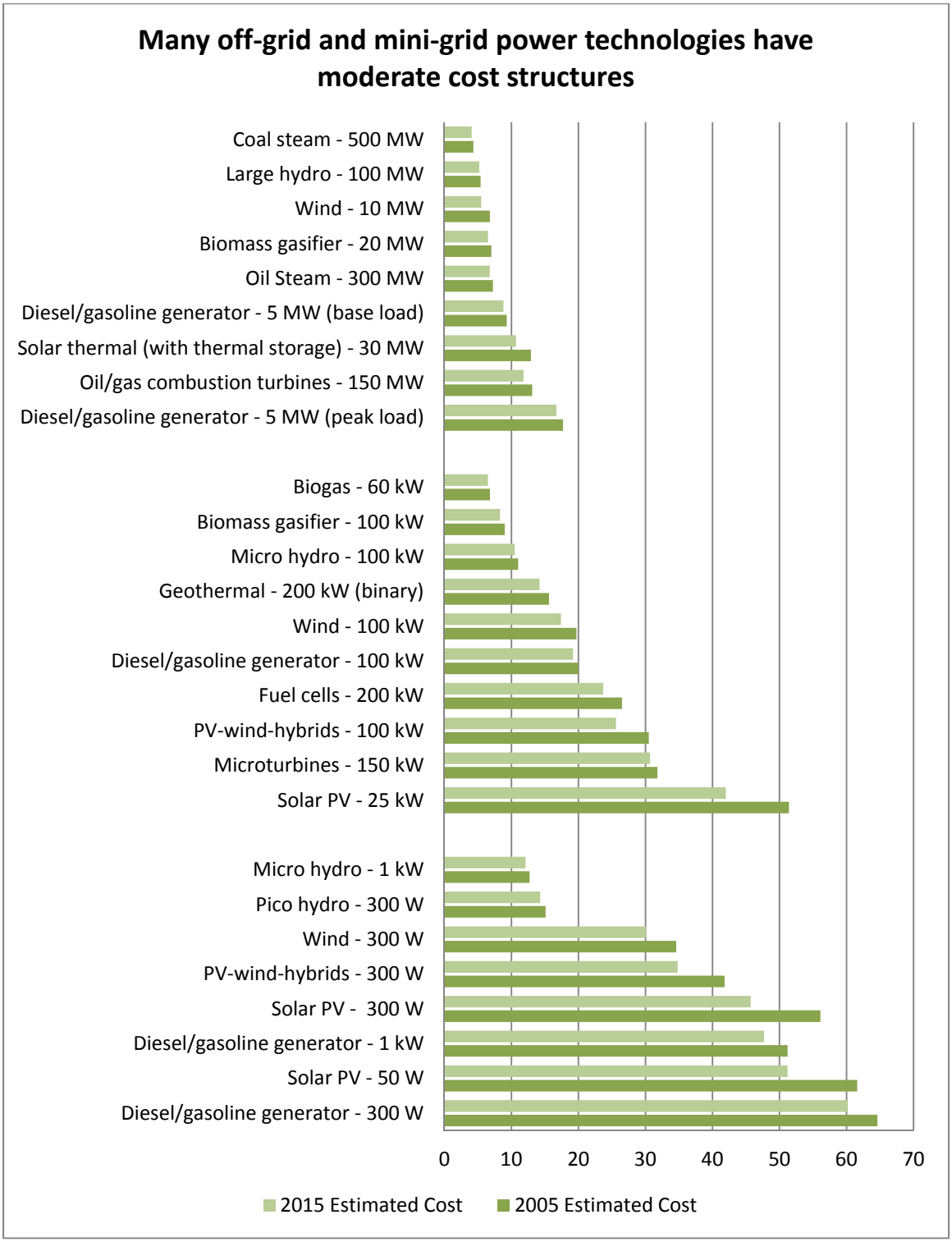
Besides distributed power generation, whether at the household, village, multi-village or district level, other approaches to helping rural consumers better meet their energy needs are the adoption of energy saving small-scale technologies such as solar lighting, solar cooking or improved cookstoves. Another way to provide viable energy alternatives to poor customers is through the adoption of alternative fuels such as bioethanol and biodiesel. These can provide cheaper energy alternatives to petroleum-based products as well as potentially enhance livelihoods through the locally-based production of biofuel-related goods and services.

In considering technological options, a key consideration is certainly cost factors. While more precise costing is very context specific, for a general sense of cost potential, the following data from ESMAP (2007) is quite helpful. In its technical study, ESMAP (Energy Sector Management Assistance Programme) sought to provide an overview of the commercial and economic prospects of renewable and fossil-fueled electricity generation technologies now and in the near future. What is particularly helpful in this study is that the assessment is specific to power generation capacity sizes. Typically power generation at a smaller scale is more expensive than larger scale generating capacity. It looked at generating technologies in three groupings by size. 'Off-grid' energy technologies had a capacity of less than 5kW, 'mini-grid' technologies were in

[13] Zerriffi (2007).

the 5kW to 500kW range, and 'grid' technologies had capacities above 500kW. The study provided a cost estimate range for 3 different time periods, 2005, 2010 and 2015. To simplify the presentation of the results, only the expected average cost of 2005 and 2015 for a sub-set of selected technologies covered by the study are represented. The other assumption made is that these estimates hold for technologies applied in appropriate settings, i.e. that wind turbines, solar PV etc are used in an environment broadly suitable for them. Also the assumed location for all technologies was India, to eliminate variables based on local cost conditions. What is expressed are comparable, levelized power generating costs on a per kWh basis that take into account technology-specific capital costs, operation and maintenance costs, and fuel costs.

Figure 6 – Forecasted Power Generating Costs Across Different Technologies and Generating Scales



Source: ESMAP (2007).

While local conditions will certainly cause considerable fluctuation in these numbers, what is useful about this graph is that it provides a broad comparison of a variety of technologies and their economic possibilities. Clearly at the off-grid scale range, pico and micro-hydro demonstrate promising cost structures, and in the mini-grid scale range, biogas, biomass gasification, micro-hydro are relatively low cost, with wind energy at both scales among the next least cost technologies. It is also interesting that for both off-grid and mini-grid levels of power generation, renewable energy technologies (RETs) are indeed estimated to be the lowest cost options.

As 60% of green house gas (GHG) emissions are due to energy use, principally from fossil fuels, energy and climate change are inextricably linked.[14] Low carbon growth is a clear global imperative. For all countries, adopting a low carbon approach does have implications for economic growth in the short term. Lower carbon approaches are often higher cost, though a primary reason for this from an environmental economics perspective is that high carbon sources of energy have long been improperly priced, with sizeable externalities that have never been factored in. Slowly, attempts are being made, through the Clean Development Mechanism (CDM) mechanism as well as at national policy levels, to redress this market failure, but meanwhile, higher carbon sources of energy largely maintain their cost advantage. For now, moving to renewable sources will in general continue to be more costly, impeding, in the short term, common measures of economic development. For developed countries, this may slow economic growth, but in the context of more conducive existing conditions to the realization of human potential, it will not seriously impede general human development. For developing countries however, limits on energy access will have deeper negative impacts on development. In some cases, energy access and low carbon growth may be conflicting objectives, however for many of the poorest in circumstances where grid-access remains only a remote possibility, fortunately there is considerable potential to promulgate systems that address both energy access and low carbon growth jointly.

[14] Ockwell et al (2009).

6. Specific Technologies and Regional Case Studies:

In order to make informed choices as to how to best support local innovation in the provision of rural energy services delivery, it is necessary to understand the initiatives that have already been undertaken. This section will briefly describe key small-scale energy technologies as well as provide a number of case examples for each that have taken place in Cambodia, Indonesia, Lao PDR, the Philippines and Vietnam.

This section will not cover all possible of technologies but will cover most of the technologies commonly discussed in the context of small-scale energy services.[15] The set of case studies presented is also not exhaustive, but an attempt was made to capture the most widely publicized examples from each of the countries above supplemented with some smaller and lesser known case studies to present a more complete spectrum of efforts in this area including some that were less successful. A few well known examples from other parts of the world are also provided.

Biogas

Biogas is produced from the anaerobic digestion of organic waste and typically comprises 65% methane and 35% carbon dioxide. It is a simple and efficient technology most commonly used as fuel for cooking, though it can be also used for lighting and generating electricity. A domestic system will require a minimum of about 20kg daily of animal manure or other organic waste, which can be provided by households with just a few head of livestock. A 4 cubic meter biodigester, which is a relatively small size, can produce enough gas to burn a single burner stove for 3-4 hours per day. Construction cost varies from $280-700[16] depending on capacity and construction location, and entails the construction of a dome for the digester as well as a biogas compatible stove for cooking. While the upfront costs are relatively high, estimated payback period due to savings on other sources of fuel for cooking is estimated to be about 3 years.

There are many benefits to biogas. Besides displacement of fossil fuel use or traditional biomass burning, health and environmental benefits include a reduction in smoke borne health problems, elimination of odour from manure decomposition, improvements in household sanitation, and reduction in chemical fertilizers due to available use of slurry from the digester for organic fertilizer. Another significant benefit is the time savings from no longer having to gather traditional biomass fuels.

[15] The one exception in terms of commonly discussed technologies is with regards to solar lighting. This technology was omitted as a member of the ITS team, Inna Platonova, is conducting in-depth research focused on this technology which will offer more insight than a sub-section on solar lighting in this paper could.
[16] Estimates from SNV.

In Asia, the potential for household biogas is promising. However, one limitation is that poorer families most often do not have access to sufficient animals to meet the amount of dung required, and better off families with sufficient animals often prefer to buy fuel rather than spend time gathering dung. Nepal, Bhutan, Bangladesh, Laos, Cambodia, and Vietnam collectively are estimated by SNV to have the potential for over 10m household biodigesters. In China, government estimates the potential at 130 million by 2015, with 42 million targeted by 2010.

Case Study 1: Vietnam, 2003-2007, SNV Vietnam[17]

Benefits: 27,000 household level biogas plants constructed in 20 provinces in Vietnam. Labor savings of 1-1.5 hours per day and US$7/month saved in fuel costs. Rural job creation of 300,000 labour days for rural masons, valued at about US$1.2m.[18] Sanitation also improved with toilets attached to 40% of digesters. Farmers also affirmed that the use of the digester improved the quality of the local environment such as the groundwater, soil and air. In fact a customer survey seemed to indicate that the environmental improvements were the main incentives to buy a digester. Reduction in GHG was estimated at 75,000 tons/year. The programme is trying to secure its Certified Emissions Reductions.

Background: Many biogas programs have been attempted in Vietnam but none had previously achieved significant scale nor long-term operational success. Despite that history, the governments of Vietnam and the Netherlands agreed to embark on this project starting 2003. Plans to 2011 are to reach 35 provinces and install a total of 150,000 plants, which will provide 800,000 with improved energy services.

Sustainability: The main objective of the project was “to further develop the commercial and structural deployment of biogas, at the same time avoiding the use of fossil fuels and biomass resource depletion”. Key was development of a commercially viable biogas sector.

Institutional arrangements: The program resides in Vietnam’s Ministry of Agriculture which was a strong supporter and advocate amongst other ministries. Provincial and district level governments were also trained to be involved and understand the program, and provincial governments had to make a financial contribution to be part of the program.

Capacity building: Much effort was made to build the capacities of the local masons with regular quality control workshops, refreshment training and even competitions.

Financial Issues: With approximate costs of US$400/digester, payback for rural household is 2-3 years.

Challenges: Maintaining high quality and reliability is a key challenge. Securing CDM revenues is a challenge as compliance with rules and regulations is not easy. Innovation needed to enable CDM revenues to benefit poor households.

[17] Teune (2007)
[18] Reported as 5 Euro per month savings and 750,000 Euro in labour costs. Converted at interbank rates in June 2008 of about 1.57 Euro/US$.

Case Study 2: Cambodia, National Biodigester Programme, 2006-2009[19]

Benefits: Nearly 6,000 biodigesters installed by August 2009, directly benefiting 30,000 people. Created employment for 450 people, 370 of which were farmers and the rest technicians. 21 private biogas companies have been established. 95% of constructed plants are in operation. 10% have toilets connected to the digester. 75% of bio-slurry is used as organic fertilizer. Each biodigester resulted in fuel savings of 6-9kg of wood fuel and .2 L of kerosene daily. Monthly fuel savings were $10-15/household, with daily labour savings of about 2 hrs. 1500 masons and supervisors will be trained in the construction of biodigesters. In total there have been estimated savings of 123,000 tons of GHG emissions.

Background: A minimum of 20kg animal and/ or human waste is needed daily. It's estimated that 25% of Cambodia's rural population can potentially install biodigesters.

Institutional arrangements: A joint initiative between Cambodia's Ministry of Agriculture, Fisheries and Forestry and the Dutch NGO, SNV. Provincial Biodigester Program Offices were set up in 5 provinces and local NGO CEDAC was also involved in this project.

Capacity building: Training of masons has taken place in the areas of marketing, construction and after sales service.

Financial Issues: With approximate costs of US$400/ digester for a 4 cubic meter digester, payback for rural household is 2-3 years. The most popular size is a 6 cubic meter digester which has an average cost of US$480 suggesting payback period of just over 3 years. Two large microfinance institutions provided special loans for biogas plants with an interest rate of 1.2% per month. For the NBP, farmers received a subsidy of US$150, reducing the payback period by a year.

Challenges: Maintaining a high level of quality in service delivery appears to have been an issue. With considerable potential for biogas digesters in Cambodia the take up rate appears modest. The Klerx (2007) report seems to indicate concerns about the capabilities of the trained masons to adequately manage marketing, construction and after sales service.

[19] From NBP website, http://www.nbp.org.kh/page.php?id=2 and Klerx (2007).

International Success Story: Domestic Biogas in Nepal

Implementation began in 1992 with advisory support by SNV and funding from Dutch, German and local funders. As of 2004, there were 115,000 biogas plants installed with 95% still in operation. There is a 25% subsidy provided as well as microfinance payment arrangements available to consumers. By 2004 there were 44 private companies installing biogas plants whereas there was only one state-owned company doing them when the project was launched in 1992. As well there are 13 appliance workshops, 80 MFIs and 36 NGOs working with them. The Nepali government provided financial as well as policy support. Other key elements to their success included: emphasis on quality, an elaborate quality control system as word of mouth farmer-to-farmer promotion of biogas considered very important. An important stakeholder in this effort was the Alternative Energy Promotion Centre (AEPC). This organization was set up by the government of Nepal in 1996 to serve as an intermediary institution between operational level organizations (NGOs and private sector entities) and various government agencies, notably the Ministry of Finance (MoF), Ministry of Environment, Science and Technology (MoEST) and the National Planning Commission (NPC). Besides biogas, AEPC also facilitates activities around a variety of energy technologies including solar home systems, micro hydro and improved cookstoves.

Source: Bajgain and Heegde (2004).

Biomass Power Generation

Biomass power generation describes the use of materials of recent biological origin as a source of energy. It can be used in a variety of ways, for electricity generation, heating or transportation fuel.

Converting biomass to energy can take place via a number of processes. Combustible biomass such as agricultural wastes like sugarcane bagasse, sisal waste, coffee or rice husks, groundnut shells or even wood from energy plantations can be burnt in boilers to generate steam for steam engine generators or steam turbines for electricity. In general the waste generated in agro processing is a good candidate for biomass generation as such wastes are rarely returned to the field and thus their use as fuel is unlikely to have a detrimental long term effect on soil management, unlike other crop wastes.

Alternatively biomass can be used for feedstock in gasification systems. Gasification is a thermochemical process in which biomass is heated with little or no oxygen to produce a low energy gas which can be used to fuel a gas turbine or combustion engine to generate electricity. Gasification can decrease emissions levels compared to power production with direct combustion.

Biomass can also be converted to biofuels. The promotion of sustainable, low carbon biofuels as an alternative to petroleum based fuels can potentially reduce GHG emissions, diversify the fuel sources for transportation and other motorized needs as well as potentially create income generating activities for poor rural populations. However increased use of biofuels can also result in accelerated deforestation, habitat destruction, higher food prices and greater food insecurity. Bioethanol is a common biofuel produced by the fermentation of plants with high sugar and starch content. It can be used in pure form but is usually a gasoline additive. Non-edible oils such as jatropha, pongamia, neem kusum are converted to biodiesel using trans-esterification and can be used in diesel generator sets with no adaptation required. Edible oils can be converted to biodiesel as well but are generally too valuable to be used in this manner.

Case Study 3: Cambodia – SME Renewable Energy Ltd, 2006-present[20]

Benefits: Use renewable agricultural waste products such as rice husks, corn cobs, sugar cane 'bagasse' or wood from local tree farms to produce a gas that can replace 75-100% of imported diesel or other fossil fuels. Since 2006, when it received its first order, SME has installed or received orders for 12 gasification systems with an accumulated value of US$800k. A typical 2 ton/hour rice mill operating for 10 hours per day for 25 days/ month will save 60,000 L of diesel worth US$54k annually.

Background: Target customers for SME RE's systems are small and medium enterprises (SMEs). SME Cambodia supported visits by Cambodian rural SMEs to India and Sri Lanka in 2004-05 to see biomass gasification equipment at work.

Sustainability: As this initiative is run on purely commercial terms, sustainability is necessary for survival. Biomass gasification and other biomass fueled technologies should have a promising future if the enterprise is well-managed.

Institutional arrangements: SME Renewable Energy Ltd is a joint venture between SME Cambodia, a Cambodian NGO promoting rural private sector development, and E+Co, a US-based non-profit renewable energy investment company.

Capacity building: Plans are being made to manufacture some system components domestically.

Financial Issues: Payback period for rural SMEs will be 1.5-3 years. In total E+Co has invested US$1.2m, with the first investment made in 2004 and the second in 2007. In 2007 E+Co approved a $600k credit facility to make loans to finance the purchase of the gasifiers.

Challenges: Convincing conservative rural business owners on the viability of using a new form of energy generation.

[20] http://eandco.net/investments/sme-renewables/

Mini, micro and pico hydro

As highlighted earlier, mini, micro and pico hydro reside at the lower end of the cost spectrum for smaller-scale energy generation technologies. There is considerable potential for such 'small' hydro approaches in hilly areas. In some areas of Laos there is already a thriving local mini and pico hydro industry, and some areas of the Philippines and Indonesia also seem well suited for greater small hydro adoption.

Pico hydro refers to systems with a generating capacity of less than 5kW and would be suitable for one or several households for lighting or other forms of light energy use. At such low levels of power generation, pico hydro systems have little impact on natural water flow.

Micro hydro systems are generally defined as having a generating capacity of 5-100kW, and mini hydro systems as generally more than 100kW but less than 1MW. A micro hydro plant can serve one village or several small villages and would typically feed into a mini grid. A mini hydro plant can serve a fairly large area and may in some instances be able to supply excess power to an integrated grid system. One advantage of hydro systems in areas with reliable water flow is they offer a more consistent energy supply than solar and wind which are more subject to the vagaries of weather. One disadvantage however is the relatively high upfront costs for micro and mini systems. Besides the turbines, each connected home also requires the installation of a home electrical system.

Case Study 4: Philippines, Save the Ifugao Terraces Movement (SITMo)[21]

Benefits: Installation of 13 micro-hydro systems in remote villages in Ifugao province. Provided light and power for 190 families. Power was used to charge batteries as well as provide mechanical power for milling. A small number of households had used diesel generators previously, and most had used kerosene for lighting. It was estimated that 75% of kerosene use was replaced, thus a saving of 32 tonnes of GHG annually.

Technology: SITMo and the Philippine Rural Reconstruction Movement (PRRM) have developed 3 basic pico and micro-hydro systems, the Firefly (100W), the Butterfly (3kW), and the Dragonfly (up to 50kW). The Butterfly was developed by a local farmer who taught himself the essentials of mechanical engineering and made the turbine from locally-obtained parts.

Institutional arrangements: SITMo was established by PRRM, the oldest NGO in the country, in 2000. It brings together public, private and social institutions working on sustainable development in Ifugao. PRRM and SITMo work with existing people's organizations or establish a new people's organisation, which is responsible for planning and organizing the manufacture and installation of the equipment.

Capacity building: Each system is run by a local cooperative with members trained in basic maintenance taking turns as overseers and operators.

[21] Info from the Ashden Awards website on 2005 Ashden Award winners, http://www.ashdenawards.org/files/reports/SITMO%202005%20Technical%20report.pdf.

Financial Issues: SITMo sourced funding for most of the capital costs from government sources and international donors. For the Firefly, capital costs were about US$900. Households benefiting bought their own batteries and home electrical system costing US$90-130 and a credit scheme was offered to help pay for this, as well users were charged weekly fee of US$.50/week towards the maintenance of the turbine. For the larger systems with capital costs of between US$400-1800/kW, beneficiary households paid about US$20. This collection represented about 20% of the total capital costs of the system. Each house hold also had to buy their own home electrical systems for US$30-40.

Challenges: While users are able to cover running costs, possible unwillingness to cover capital costs remains a significant barrier to scaling up, though in this community it is not clear whether or not that willingness has been tested. Also, with the implementation of a significantly subsidized program such as this, this may have a negative impact on the willingness of potential users to cover such costs.

Case Study 5: Laos, Lao Institute for Renewable Energy (LIRE), ETC-LIRE Pico-hydropower Innovation and Capacity Building Program[22]

Benefits: Affordable off-grid power for rural households and many small-scale entrepreneurs involved in the importation, distribution, sale and servicing of pico-hydro units.

Background: Pico-hydro is quite commonly used in the Laos, particularly in the mountainous north. LIRE has been working since 2008 to improve the quality, safety, efficiency and reliability of pico-hydro systems. ETC Energy of the Netherlands has provided support to its capacity building program. The main goal of the programme is to improve the use, quality and safety of pico-hydropower turbines in the Lao PDR. In order to do so, the project targets all actors in the supply chain of this low-cost electricity generator: traders, shopkeepers, end-users and government staff. A participatory approach was developed to assess the needs and start activities to build the capacity of the various stakeholders in the supply chain. The recently approved second phase of the programme will provide resources to implement these activities in at least three provinces in the North of the country.

Sustainability: As an active private market already exists for pico-hydro, sustainable adoption of the technology has been proven.

Capacity building: This project seeks to understand the capacity building needs of all actors in the value chain to enhance the benefits of this technology.

Case Study 6: Indonesia – Cinta Mekar, Community Based Micro-hydro Development, 2004 to present[23]

Benefits: A 120kW micro-hydro power station was installed and connected to the grid in the village of Cinta Mekar in West Java. The power plant generates $440-770 (4-7m

[22] Vongsaly et al (2009).
[23] http://www.energyblueprint.info/fileadmin/media/documents/national/indonesia_report.pdf

rupiah) monthly for the community due to its grid connection and funds are used to support a variety of village priorities.

Background: The impetus for the project came out of the 2002 WSSD in Johannesburg which identified pro-poor public private partnerships as a mechanism to provide infrastructure to poor communities.

Sustainability: After the initial capital cost contribution, the revenue generated by the power station will more than cover its operating costs. However the capital cost contribution of $150k was a significant sum, and may not be easily replicable.

Institutional arrangements: Following the initial investment made by grant contributions, the community manages and maintains the power plan with the help of capacity building support from IBEKA (People Centred Economic and Business Institute).

Capacity building: Establishment of a micro hydro power training centre to serve local and foreign groups interested in micro hydro. The installation is managed by the local community and only facilitated by IBEKA.

Financial Issues: Financial support came from the government of the Netherlands through UNESCAP via a $75k donation, and the grid operator also contributed $75k. As well, the local NGO IBEKA contributed $75k to establish a training centre in Cinta Mekar for people from Indonesia or other ASEAN countries wanting to learn about how to develop a micro hydro project.

Solar PV

Solar PV kits are typically used in a low energy demand context for such as for lighting, and powering a radio or TV. Solar PV applications range from simple LED solar lanterns to solar home systems (SHS). Systems consist of a photovoltaic panel, battery and regulator and usually generate of the order of 6, 12 or 24 volts. PV systems are rated by their ‘watt-peak’ (Wp) rating, which is the power generated under standard conditions, equivalent to bright sun in the tropics. To give some sense of system scale needed, a panel power of 60 peak watts could support 2 lights and a B&W TV, a panel power of 120 peak watts could support 3 lights and a colour TV.

Service life of a solar panel is about 20 years, however battery life is only 3 years, incurring financial and environmental costs as the battery is regularly replaced. As well, the initial cost of the system can be high, in the range of $300-$700 depending on its watt peak rating.

Dissemination of solar PV requires considerable commitment as long term technical support is needed as well sustained management of battery replacement and disposal. As well, with high initial costs medium-term credit needs to be arranged in order to enable purchase for poor rural users.

In South Asia, solar home systems have experienced considerable take up. Grameen Shakti had installed 220,000 SHS in Bangladesh as of 2009 with 1m targeted for installation by 2012. In southern India, SELCO has sold more than 85,000 SHS.[24] A similar scale of take up has not however been observed in South East Asia, though the experience of Lao PDR indicates reasonable potential for this technology.

Case Study 7: Vietnam, SELCO Vietnam[25]

Benefits: 1,600 units sold

Background: SELCO is a US-based company that grew out of the NGO the Solar Electric Light Fund founded in 1990. The for-profit SELCO was launched in the late 1990s to scale up provision of solar electricity through a market-based approach. Its primary focus was the sale of SHS to households, however it also sold solar street lights, water pumps and hot water heaters.

Sustainability: As of 2006, SELCO Vietnam was still struggling

Institutional arrangements: Had a partnership with the Vietnam Bank for Agriculture and Rural Development (VBARD).

Financial Issues: Received a US$750k loan from the IFC's SME Program in 1998. Loan was partly to enable SELCO to provide collateral to third party financial intermediaries for working capital financing and also to secure loans for customers. Typical costs for an SHS were in the US$500-700 range.

Challenges: At the time of its launch, microcredit was still a relatively new idea in Vietnam and potential consumers were reluctant to take on loans. VBARD ultimately failed to make financing available to customers and SELCO Vietnam had to take on consumer financing which it was not well equipped to do.

Case Study 8: Laos, Sunlabob Rural Energy Ltd[26]

Benefits: 1870 SHS rented to families in 73 different villages providing safer and cleaner lighting and providing power for other low level energy needs such as radios or recharging batteries. Besides the rental units, 5,600 SHS have been sold in Laos. As well, 500 portable solar lanterns are being leased.

Background: Sunlabob was set up in 2001 to provide renewable energy services to those living in remote, off-grid areas. Besides the rental of solar PV equipment, Sunlabob is also involved with micro-hydro, biogas and diesel generators running on jatropha oil. An interesting innovation by Sunlabob is a timer on every solar lantern that limits use to 15 hours to protect the battery from being deep-discharged. It also has an interface that allows use to be tracked. This also assists with financial as well as CDM

[24] Energy for All (2009).
[25] IFC (2007)
[26] Ashden Awards write up available on website

issues related to the lanterns. The potential market for Sunlabob is estimated at 10-15% of the country's households, close to 1 million people. Sunlabob helped set up the Lao Institute of Renewable Energy (LIRE) to carry out research and policy work that it would not be appropriate for a single company to undertake, and for it to be a independent voice of renewable energy.

Sustainability: Sunlabob is a commercial entity that in surviving this long has clearly demonstrated its sustainability. It's business model appears replicable outside of Laos and in 2008 Sunlabob became active in Thailand through its franchise partner Samui Service Solarpower Ltd. In Thailand the focus is more on solar water heating than SHS. In 2009 Sunlabob also started working in Uganda with a local partner. Quality control and customer support have been key success factors for Sunlabob.

Institutional arrangements: Sunlabob uses a carefully selected and trained network of franchises to install and maintain its solar PV equipment. It uses an innovative rental mechanism whereby the equipment is rented to the Village Energy Committee (VEC). The VEC is selected by the village community and leases the equipment to individual households.

Capacity building: Besides training those who are part of its franchise network Sunlabob requires these franchises to train technicians in the villages to perform day-to-day maintenance of its equipment. Through its utilization of VECs villagers themselves are in control of setting prices, collecting rents and performing basic maintenance.

Financial Issues: The VEC is responsible for the collection of payments from the villagers. This allows the VEC to be flexible if someone cannot pay as well as invokes the Grameen Bank rationale that peer pressure will motivate payment. Rental costs for SHS are between $4-15/month. Typical monthly household expenditure on kerosene is $$3.50-6 so cost savings are possible. Additionally the danger from fire and the environmental costs of kerosene are avoided.

Case Study 9: Philippines – Project Access (Accelerating Community Electricity Services Using Solar)[27]

Benefits: Launched in April 2010 so benefits still to be realized. Has aggressive targets to install 30 systems or 25% of barangay households, whichever is larger, in targeted barangays, within the next 12 months. This will mean at least 2,400 SHS should be in place by mid 2011.

Background: Launched by the Department of Energy (DOE) to support the Philippine government's goal to achieve 100% barangay electrification by 2009 and 90% household electrification by 2017. Subsidies favour the smaller SHS. A 20 Wp system generates sufficient electricity to run two light bulbs, power a transistor radio and charge a mobile phone. 78 barangays have been targeted for this initial phase of the project. Maintenance of the systems must be provided by the participating providers for at least

[27] *www.doe.gov.ph/rpp/.../ppt/a.1%20solar%20pvsubcomponent.pps*

five years. To ensure compliance there is a performance bond requirement of 45% of the contract value.

Sustainability: Systems will be offered on a commercial basis after the provision of subsidy on capital costs provided by GEF as well the DOE. These subsidies are sizeable.

Institutional arrangements: This is a collaboration between the DOE and participating PV companies (PCs) who need to be approved by the DOE. Arrangements are also in place with MFIs to provide financing.

Capacity building: Some capacity building of PCs will be provided on a cost-shared basis.

Financial Issues: GEF subsidies will be $2.50 per Wp for 10-50 Wp systems, $1.50 per Wp for > 50Wp-100 Wp systems. Government subsidies will be $170 per system for 20-30 Wp systems and $85 per system for >30-50 Wp systems. Without subsidy a 20 Wp system would cost $380-$430. With the subsidy the cost will range from $210-$260, almost halving the cost. Arrangements have been made for microfinance to be made available to finance the purchase of the systems. For a loan term of two years monthly payments will be about $10 for 20 Wp system, falling to $7/month for a 3 year term. A $1m loan guarantee fund has been put in place to partially cover loan losses from purchasers and suppliers

Case Study 10: Indonesia – Solar Home System Project, World Bank, 1997-2003[28]

Benefits: 8,054 units were installed, serving 35,000 people.

Background: The World Bank and the Global Environment Facility (GEF) launched the project in 1997 to help Indonesia achieve the 1 million SHS target set by the government. The project's goal was to promote the market acceptance of solar home PV systems in an effort to reduce dependence on fossil fuels and strengthen institutional capacity to support and sustain solar-energy based rural electrification. The initial target was the installation of 200,000 SHS. However with the onset of the Asian financial crisis these targets were dramatically scaled down.

Sustainability: Even with subsidy, take up was very low. The impact of the financial crisis on demand was likely quite severe.

Institutional arrangements: Private operators were charged to sell and maintain the SHS.

Capacity building: The World Bank evaluation claimed considerable capacity building of private sector partners occurred.

Financial Issues: The World Bank and GEF provided subsidies of $2 per Wp, which would cover about 20-25% of the SHS cost. There was a lease arrangement in place with a payback time frame of 3 years.

[28] http://www.ccevaluation.org/inventory/g1/g1/166-GEF.html

International Success Story: PV Solar in Bangladesh – Grameen Shakti

By the end of 2009, Grameen Shakti (GS), a Grameen Bank subsidiary, had installed 113,736 SHS with plans to nearly double that to 220,000 by the end of 2010. It has over 100 unit offices distributed throughout Bangladesh. Several microfinancing options are available ranging from 15-25% downpayment to repayment terms of between 24-26 months and service charges of between 8-12%. GS engages continually in innovation, or what they call 'adaptive research'. They work on developing accessories for SHS, product development to reduce product cost, ways to build the capacity of the practitioner. An interesting operational innovation is that they provide a 3 year warranty on the system and combine a monthly servicing visit with monthly payment collection. They also offer post-warranty servicing at $5/year, though major repair costs need to be paid by the user. They feel some of their key success factors include: sound program design, constant monitoring and evaluation, maintaining high quality standards. GS also intends to expand its operations to encompass biogas, wind power and other technologies.

Source: Barua (2004) and GS website (www.gshakti.org).

Small Wind Power

Wind power is one of the most mature renewable energy technologies and over the last two decades has become the world's fastest growing energy source.[29] The operating range for wind turbines is very wide, ranging from 6MW turbines with 60m blades for off-shore wind farms to 50W battery chargers with 25cm blades. Small wind generators for home use have generating capacities of the order of 100W. Typically these systems are comprised of a turbine, battery and controller to protect the battery from overcharging, and also an inverter to convert DC to AC. Costs to install a 100W system are estimated at $300-400. For turbines in the 100kW range per kW prices are in the $3000-5000 range. The other appeal of wind power is the low operational and maintenance costs which are estimated to be only 4% of turnkey costs over the lifetime of the turbine.[30]

Small wind can be an economical source of power particularly for nomadic and semi-nomadic herders residing in areas of reliable wind resources. In Asia there has been particularly strong take up in Inner Mongolia where an estimated 130,000 small wind generators are in daily use.[31]

[29] Greenpeace International and EREC (2007).
[30] http://www.ashdenawards.org/wind#notes
[31] Energy for All (2009).

Case Study 11: Vietnam – RECTERE, Household wind installations, 1990-present[32]

Benefits: 900 household wind systems of 150-200 Wp installed by the Research Center for Thermal Equipment and Renewable Energy (RECTERE) of Ho Chi Minh City Technical University.

Background: Geographically, Vietnam has a relatively good potential for wind energy. With respect to small wind energy, experimentation started in the late 1980s with household energy systems. The main Vietnamese institution involved in this sector is the RECTERE, which has installed 900 systems to date, the largest implementation of small wind systems in Vietnam. The 150 Wp unit can power lights, TV and radio.

Sustainability: 90% of these wind systems disseminated to rural families through government grants, with only 10% purchased directly.

Institutional arrangements: Government-subsidised scheme but the particular departments involved are not clear. RECTERE extends its maintenance and after sales service through a network of technicians available in each province. (In 2006, researchers and professors from RECTERE formed an enterprise, the
Bach Khoa Investment and Development of Solar Energy Corporation (BK-IDSE), with the goal of bring research results to the market. It is not clear how successful BK-IDSE has been to date.)

Capacity building: Capacity building of technicians took place.

Financial Issues: The 150 Wp unit has a cost of about $270. As most units were provided by the government, it does not appear that microfinance arrangements had been arranged.

Challenges: This seems a promising opportunity for further scaling up. The upfront capital costs appear low relative to the energy output, and combined with wind's relatively low operating and maintenance requirements, the economics look appealing. It would be interesting to understand why dissemination has been so limited.

Case Study 12: Cambodia, Wind-Powered Water Pump, Cambodia Development Institute (CDI), 2007[33]

Benefits: Savings of US$200/year relative to a standard generator. No GHG emissions.

Background: Local NGO motivated to experiment to develop a suitable prototype.

Sustainability: No evidence of further take-up.

Institutional arrangements: Pilot project undertaken by one local NGO.

[32] Nguyen (2007).

[33] http://www.un.org.kh/undp/Energy-environment-project-stories/Cambodian-NGO-creates-wind-powered-water-pump-for-small-scale-farming.html

Financial Issues: Wind pump costs of US$500. Pilot supported by GEF Small Grants Programme in 2007 with US$11,000 grant.

Improved Cookstoves

As traditional biomass will remain the predominant cooking fuel for large numbers of rural poor for the forseeable future, improved cookstoves (ICS) can represent a simple, low-cost but significant improvement in terms of energy efficiency, time saved from gathering fuel, as well as improved health outcomes from better management of indoor pollution from cooking.

ICS offer simple design features such as a well-designed burning rack, optimally sized combustion chamber and limited space under the cooking pot to induce heat transfer. This can result in savings of 15-30% of traditional biomass used. While ICS,are typically affordable for poor families and no special credit terms need to be arranged, they do tend to be more expensive than traditional cookstoves. Often the primary concern of a household considering the purchase of an ICS is not the fuel savings but its performance relative to the purchase cost. Some ICS enable the ability to cook and heat water simultaneously, others may allow the use of a wider range of biomass fuels, and other designs may improve the cooking process in other ways.

Some factors in the success or failure of ICS adoption include cost considerations, the durability and functionality of the stove, cultural compatibility with traditional cooking methods and also the robustness of the market, such as the maintenance of consistent quality standards by ICS manufacturers.

WHO/UNDP[34] data compiled from government sources indicate some take up of ICS across all the countries of interest in this study. Of the population relying on traditional biomass fuel for cooking, the following percentages in each country are using ICS: Cambodia 7%, Indonesia 5.1%, Lao PDR 12%, Philippines 16%, Vietnam 22%.

Case Study 13: Cambodia, GERES, Cambodian Fuelwood Saving Project (CFSP), 1997-present[35]

Benefits: Adoption of ICS reduces household charcoal use by at least 22%. 1 million 'New Lao' stoves have been produced as of March 2010 by local entrepreneurs since production first began in 1996, with commercialization beginning in 2002. It is estimated that over 130,000 households currently use the New Lao stoves. Use of ICS contributes to a significant reduction in GHG emissions and through to 2009, total reduction in GHG emissions was estimated at 300,000 tonnes. ICS are also better insulated, thus reducing the risk of burns. They create less smoke and soot, and improved heat transfer means food cooks more quickly. Producers also have higher margins on the new Lao stoves versus traditional stoves.

[34] WHO/UNDP (2009).
[35] Ashden Awards summary and GERES (2009)

Background: Similar in design to the traditional Lao stove but more efficient and more durable.

Sustainability: Monthly sales of 25,000 and continued growth since 1996 are promising evidence of sustainability.

Institutional arrangements: A network of distributors and retailers has been established and a trade organization set up to oversee pricing and quality, the Improved Cookstove Producers and Distributors Association of Cambodia (ICoProDAC). ICoProDAC oversees quality control, regulates prices and facilitates promotions. Each stove has a unique serial number and can be traced back to its source. The CFSP is a collaboration with the Cambodian NGO, Development and Appropriate Technology, and the Ministry of Industry, Mines and Energy.

Capacity building: Training was provided to manufacturers, with more precision required than in the manufacture of traditional stoves

Financial Issues: New Lao stoves are three times as expensive as traditional stoves but payback period is about 2 months. New Lao stoves also last three times longer. A microcredit fund has been set up to help entrepreneurs participating in the production and distribution of the stoves. Credit is subsidized and interest is 12% per annum as opposed to the 2.5% monthly charged by commercial lenders. Retail price in 2006 was about $3.50-4. No credit was made available to users. The CFSP had grant support until at least 2006 from the EU.

Challenges: While quite widespread in Phnom Penh, the stoves are less widely used in other parts of Cambodia. GERES is working to develop new stove models.

International Success Story: Improved Cookstoves in China

Between 1982-99, the Chinese National Improved Cookstoves Program (CNICP) installed 175m improved stoves in rural households. The Chinese ICS cost about $10 and the Chinese government provided a subsidy of about 10% of the cost of the stove. One reason cited for the success of the program was the widespread publicity given to the improved stove design. Other contributing factors to the large take up included – growth of self-sustaining rural energy companies that manufactured, installed and serviced the stoves; government support for stove construction training, administration and promotion support, local rural energy offices in charge of training, implementation and monitoring of the program; and well-considered design.

Source: Goldemberg (2002).

7. Innovations for Energy Poverty

There are many pathways by which energy poverty can be addressed. National governments and the private sector can explore grid expansion opportunities; smaller private sector players, NGOs and local and regional governments can promote mini-grid and off-grid approaches; and efforts to promote improvements through the introduction of simple devices such as improved cookstoves, solar water heaters and solar lighting can help address some of the end needs for energy services. Undergirding all can be an enabling policy environment that gives such efforts the opportunity to take hold and propagate. These are complementary approaches and there is no reason that all these approaches cannot be considered simultaneously. All of these efforts require some form of innovation in order to provide services currently unavailable, whether this is in the form of technological, institutional, operational, financial or policy innovation.

With the focus of this paper on smaller-scale mini-grid and off-grid efforts to address energy poverty, it is in fact at this scale where local innovation is much more likely to take place. With large, grid connected projects, much of the technology needs are outsourced to foreign firms with little indigenous innovation taking place. However, indigenous innovation is much more likely to take place with smaller, decentralized energy systems, thus "alongside distributed generation, therefore, there is an opportunity for distributed innovation – the promotion of indigenous capabilities to incrementally tinker with and adapt technologies in order to better address local needs and environments."[36]

Better adapted, smaller-scale distributed energy technologies, rather than emanating from a northern-based technological frontier, or from an established multinational looking for base of the pyramid (BOP) opportunities, will more likely arise from local innovation, which in some cases may also be relevant for other similar locations and markets. Such 'below the radar' innovation[37] needs to be better understood so as to be better identified and supported by government, through policy and practice, and by other actors.

For innovation to be truly effective, it must at some level achieve scale and replication. Gitonga and Clemens (2006) look at UNDP interventions in expanding access to modern energy services and provide a useful framework. They assert that expanding access, "especially at the community level, is about processes, and how these processes help build a country's institutional capacities both at the local and national level to scale up, replicate and mainstream on several fronts: quantitative, functional, political and organizational – often simultaneously". They define *scaling up* as

[36] Ockwell et al (2009).
[37] Clark et al (2009)

deepening the project approach and beneficiaries to a larger scale. It will typically start from a pilot project and grow to reach a larger number of people. A community may regard this as a 'vertical' expansion. Replicating is regarded as a 'horizontal' expansion, usually referring to the expansion of a program to a more beneficiaries and new geographies. *Mainstreaming* is the incorporation of project components into national or local development priorities, strategies and processes. This may entail the implementation of policies, legislation and standard specifications, and possibly establishing or strengthening institutions to support replication and scaling up.

Scaling up, replicating and mainstreaming can occur simultaneously or sequentially in various orders. Gitonga and Clemens also identify the four main prerequisites required for each of the processes to take place. These are: ***a strong institutional framework, enabling policies, an appropriate financial mechanism, and functioning codes of practice***. These elements vary in importance amongst the three forms of expansion – scaling up, replicating and mainstreaming – but all are either important or essential.

> *A strong institutional framework* requires an effective and flexible coalition that can involve national and local governments, the private sector, civil society, and the community. Any stakeholder operating in isolation will have little success. The institutional framework needs to be participatory and cross-sectoral.
>
> *Enabling policies* can include a variety of instruments that influence the implementation of project components. These instruments could relate to institutions, markets, legislation, taxation, levels of subsidy etc. Such policies could either directly or indirectly influence energy provision.
>
> *An appropriate financial mechanism* requires access to financial services to meet the needs of consumers, suppliers and/or institutions that support them. Energy technologies are capital intensive at every level and without access to appropriate financing, efforts to provide energy services cannot succeed.
>
> *Functioning codes of practice* entail standard specifications that ensure some minimum standard of functionality, quality and predictability in the delivery of services. These can be agreed and governed within sizeable local markets, nationally or even internationally in some cases. The ability to enforce such codes of practice is important in scaling up and replication. Enabling policies could include instruments to develop or enforce such codes of practice.

In the long history of development assistance there are copious examples of pilot projects that seldom sustain impact beyond the life of the project itself. In attempts to address energy poverty, the history is no different. As just one example, GTZ (Gesellschaft fur Technische Zusammenarbeit), one of the most active donors promoting solar PV technology since the 1980s, in assessing its *own* work remarked that "there has not been a single project that was designed expressly to disseminate the technology…Rather, the bulk of activities have taken the form of pilot projects or testing and demonstration projects...frequently characterized by the diffusion of a small number of systems...and public-sector counterpart institutions which showed little interest in promoting a commercial dissemination process".[38]

Building on the four building blocks identified above by Gitonga and Clemens, one other key characteristic of innovation with significant reach and impact is the ***involvement of the private sector and the utilization of market mechanisms***.

Agbemabiese (2006) asserts that small and medium enterprises (SMEs) are key to the sustainable delivery of rural energy services. His view is echoed by Prahalad and Hart (2002) who state "empowering local entrepreneurs and enterprises is key to developing the Tier 4 markets" (with Tier 4 referring to the 4 billion people at the base of the pyramid with annual per capita incomes of less than $1,500). To facilitate the involvement of SMEs, Agbemabiese (2006) identifies a number of key needs to be fulfilled, priorities being seed and 'second-stage' finance, information and training, and customer credit through third party institutions. Zerriffi (2007) also emphasizes the importance of financing and a business model in promoting distributed rural electrification.

Review and Analysis of SE Asian Case Studies

This study attempted to capture the variety of innovative, and sometimes less than innovative, efforts made by diverse actors to address energy poverty across a range of technology choices. These case studies represent a mixed experience, and this study did not intend to capture only the success stories. The key features of the various case studies are summarized in Table 2.

Taking up the thread from the previous section, innovations to address energy poverty have in some instances managed to achieve scale, replication and mainstreaming, and in other instances have not. The four building blocks identified by Gitonga and Clemens (2006), and the fifth observation on the importance of private sector involvement, are useful starting points for an analysis of the case examples presented.

[38] GTZ (1995) referred to in Martinot (2002).

The initiatives with the greatest potential, in some cases already realized, for scaling up, replication and mainstreaming would include the biogas efforts by SNV, particularly in Vietnam, but also in Cambodia. The Cambodian effort began three years later than the activities in Vietnam and most likely learned considerably from SNV's earlier experience. In both biogas initiatives the respective Ministries of Agriculture took a leading role. The actual installations were performed on a commercial basis by local entrepreneurs, and a one-off upfront subsidy was provided to consumers. Financing arrangements for repayment were also arranged with MFIs. In these instances all the key elements were largely addressed, namely a strong institutional framework, enabling policies through the Ministries, an appropriate financial mechanism, functioning codes of practice and the involvement of the private sector. It is noted however that in the Cambodian case maintaining functioning codes of practice around quality standards is a current challenge.

Another case study of considerable promise is that of Sunlabob, the Laotian private enterprise. As commented in the summary table to follow (Table 2), "Numerous innovations appear to have taken place with this effort. Sunlabob appears a dynamic, entrepreneurial firm pioneering technological innovations in hardware. As well its social innovation with respect to franchise arrangements appears a good mix of central quality control paired with decentralized local entrepreneurship. There also appears to be considerable financial innovation taking place with its leasing arrangements for both SHS and solar lanterns." With nearly 8,000 SHS either rented or sold in a small market like Lao PDR, Sunlabob can lay claims of scale and replication. While 'enabling policies' may not clearly be in place, all other key elements appear to have been addressed.

Another case achieving scale, replication and mainstreaming is the Cambodian Fuelwood Saving Project that promotes improved cookstove (ICS) technology. This is a collaboration between the Ministry of Industry, Mines and Energy and a local NGO. With 130,000 households currently using the stove it has certainly achieved scale, replication and mainstreaming and, indeed all the five key elements are addressed.

A case study of some promise is that of pico hydro in Laos. The particular case presented is a capacity building intervention, but the success story is the vibrant local market for pico hydro. With many local entrepreneurs involved in the value chain, localized innovation is surely taking place and LIRE's efforts may well propel that innovation further forward. Meanwhile scaling up and replication is occurring, and while no specific financial mechanisms are in place to promote pico hydro, its cost structure is such that the status quo market financial mechanism is already sufficient.

The biomass gasification effort by SME Renewables in Cambodia is another effort with some promise. It is a purely commercial effort though backed by social investors

through E+Co. The business opportunity for biomass gasifiers in Cambodia appears promising and if well managed, SME Renewables should survive and eventually spearhead a new RET market opportunity. The financial and quality control prerequisites would appear to be in place, however there is no clearly supportive enabling policy, nor is there a strong institutional framework assisting with the widespread promotion of biomass generation for SMEs.

The other case showing some promise is that of small wind in Vietnam. So far small wind installation has been heavily subsidized, but the estimated cost figures provided would indicate a strong business case. In this instance none of the prerequisites appear to be in place for scaling up, replication and mainstreaming, but perhaps with some focused attention could be. Currently the institutional framework appears virtually non-existent, no clear enabling policies nor special financial arrangements are in place, and functioning codes of practice or the sizeable involvement of the private sector do not appear relevant given the current level of activity for smaller scale wind installation.

The remaining cases appear less promising. Project ACCESS, the PV project in the Philippines, is very heavily subsidized. It appears already mainstreamed, and with the injection of enough resources could well be significantly scaled up and replicated. However its approach clearly distorts the market, and the history of previous attempts to scale up PV in SE Asia does not augur well. The most glaring failure is the World Bank/GEF attempt in Indonesia that had ambitions to install 200,000 SHS that only achieved slightly over 8000 installed by project end. However, this attempt was unfortunate to be launched just prior to the start of the Asian crisis of the late 1990s. In Vietnam, SELCO Vietnam also struggled, though this was attributed to not having appropriate financing in place. Project ACCESS appears to have sufficient financial resources allocated to it to achieve its defined project goals, but without further financial subsidy seems unlikely to motivate sustained impact beyond those goals.

The two micro-hydro cases are also less promising examples. In both cases significant subsidy was provided and no scaling up or replication of the model appears likely to occur without similar levels of subsidy. The business case for micro hydro is generally promising however, and it would be good to see a case that tests a community's willingness to pay in the absence of such subsidy. Some social and financial innovation could be called for.

Finally, in the case of the one-off wind powered water pump, this is simply a classic example of a one off activity disconnected from market processes of any sort that is unlikely to have any development impact.

Table 2 – Summary Table of Case Studies

Country	Technology	Project Summary	Institutional Framework	Financial Mechanism	Capacity Building	Other Comments
Vietnam, 2003-07	Biogas	27,000 hh biogas plants installed, improved sanitation, to be sustained by local entrepreneurs and a commercially viable biogas sector. Goal to install 150,000 by 2011.	Championed by Min of Agriculture, capacity building provided by intl NGO (SNV), implemented by local entrepreneurs	Microfinance loans, with payback of 2-3 years.	Quality control workshops for local masons	With the program championed by the Min of Agriculture, manageable financing arrangements for consumers and implementation driven by local entrepreneurs, program well-placed to achieve scale, replication and mainstreaming. Challenge will be the maintenance of quality standards to keep consumers satisfied.
Cambodia, 2006-09	Biogas	6,000 hh biogas plants installed by 2009, 21 private biogas companies established	Joint initiative by Min of Ag an intl NGO (SNV), local NGO CEDAC involved	One-off subsidy of $150 from NBP reduces payback period by a year. MFIs provided special 1.2% loans	Capacity building training in marketing, construction and after sales service	This program, structured in much the same way as Vietnam's has, high potential to expand further in terms of scale, replication and mainstreaming. Currently problems in quality control cited, but institutional and financial framework appear sound.
Cambodia, 2006-present	Biomass gasification	Targeting rural SMEs to invest in biomass power plants; to date 12 systems ordered for total value of $800k	Joint-venture between local NGO SME Cambodia and intl non-profit, E+Co (JV called SME Cambodia). total E+Co investment is $1.2m	Payback period for rural SMEs will be 1.5-3 years. E+Co approved a $600k credit facility to make loans to finance the purchase of the gasifiers.	Learning by doing capacity building for SME RE.	Market potential exists but this initiative has no particular policy support nor enabling financial mechanisms. Survival will be on purely commercial terms. May take patient capital to wait for market to see the opportunity.
Philippines, 2000-present	Micro-hydro	13 micro-hydro systems installed in remote villages benefiting 190 families	Local NGO PRRM established SITMo, a multi-sectoral group working on sustainable development in Ifugao province; PRRM and SITMo worked w community groups to	80% capital costs covered from govt and intl donors. Hhs needed to buy home electrical system of $30-130 and credit scheme organized to help pay for this, also	Local cooperative trained in basic maintenance as well as in management of a community resource.	Heavily subsidized with little scaling up, replication or mainstreaming potential in its current form. Testing a less subsidized model could show promise. SITMo continues to source for grant support to bring more microhydro projects onstream.

Country	Technology	Project Summary	Institutional Framework	Financial Mechanism	Capacity Building	Other Comments
			establish a people's organization responsible for planning and organizing the manufacture and installation	charged $0.50/wk for turbine maintenance. For larger systems (w cheaper home systems), $20 capital cost contribution required		
Laos, 2008 onwards	Pico-hydro	Improving quality, safety, efficiency and reliability of pico-hydro, already common in mountainous north by building capacity of all actors in the supply chain: traders, shopkeepers, end-users, govt staff	Implemented by LIRE with grant support from ETC (Netherlands).		Seeks to build capacity of all actors in the value chain.	Embedded in a self-sustaining local market environment this intervention can potentially further strengthen the local market. A capable NGO could well uncover policy opportunities that could assist to further mainstream the adoption of this technology.
Indonesia, 2004-present	Micro-hydro	Installation of 120kW micro hydro plant in West Java. Generates $440-770 monthly for the community.	UNESCAP, the grid operator and local NGO IBEKA provided considerable financial support.	Village residents obtain grid-based electricity. Grant contributions were $75k from each of the three organizations involved.	Local community manages the power plant. IBEKA's support funded a micro hydro power training centre	As a demonstration site it could contribute to future dissemination of the micro hydro technology, however no particularly institutional, financial or technological innovation has arisen from this heavily subsidized project.
Vietnam, late 1990s	Solar PV	Private distribution of solar home systems (SHS) to households by SELCO Vietnam. As of 2006, 1600 sold. Reports were that SELCO Vietnam was still struggling.	Vietnam subsidiary of US-based company SELCO. Funded by $750k loan from IFC in 1998.	Partnership between Credit arrangements were to be made w Vietnam Bank for Agric and Development (VBARD), but ultimately SELCO VN took on consumer financing and was not successful at it.		Failure in organizing a suitable financing mechanism appears to have incapacitated this effort.
Laos, 2001-	Solar PV	1870 SHS rented to families, 5600 SHS	Sunlabob works through franchisees	Sunlabob a sustainable private		Numerous innovations appear to have taken place with this effort. Sunlabob

Country	Technology	Project Summary	Institutional Framework	Financial Mechanism	Capacity Building	Other Comments
present		sold, 500 portable solar lanterns leased. Some technical innovations introduced.	carefully trained and selected. For rental program rents equipment thru a Village Energy Committee (VEC) whose members elected by community. VECs control price setting, rent collection and basic maintenance	enterprise. VECs permitted to be flexible w payment arrangements, and invokes Grameen Bank peer lending model to help motivate payment. Rental costs $4-15/month.		appears a dynamic entrepreneurial firm pioneering technological innovations in hardware. As well its social innovation with respect to franchise arrangements appear a good mix of central quality control paired with decentralised local entrepreneurship. There also appears to be considerable financial innovation taking place with its leasing arrangements for both SHS and solar lanterns.
Philippines, 2010-onwards	Solar PV	Project Access	Launched by the Dept of Energy in April. Supported by GEF. Has the aggressive target to install SHS in at least 25% of households in 78 targeted barangays. Approved participating companies (PCs) will implement the program. Part of government's goal to achieve 100% barangay electrification by 2009 and 90% hh electrification by 2017.	Sizeable subsidies are being provided for SHS, with greater relative subsidy for units 50Wp and below. For a 20 Wp system cost will be $210-260 as opposed to $380-430 without subsidy. Loan scheme has been arranged so payments will be in th $7-10/month range for 2 or 3 years.	There will be PC capacity building on a cost-shared basis.	Clearly the government is highly motivated to reach its goals. While GEF is contributing as well, the govt is subsidizing each SHS for $170 for smaller 20-30 Wp systems. At such a high level of subsidy, PV systems are already mainstreamed, and well positioned to scale up and replicate. However given high operating and maintenance costs for solar PV it will be interesting to see how this effort is sustained over time.
Indonesia, 1997-2003	Solar PV	Solar Home System Project. Project launched in 1997 to help achieve 1m SHS target by govt. Target for the project was 200,000, but by 2003, only 8,054 units installed.	The World Bank and GEF provided support to the GoI's goal of 1m SHS. As with Project Access above, private sector partners were sell and install the SHS.	With the subsidy amounting to 20-25% of the cost, there was little take up. Take up also may have been significantly affected by the Asian financial crisis which saw enormous Rupiah devaluation.	The World Bank evaluation claimed considerable capacity building of participating companies occurred and that a new financial mechanism had been tested.	Poor timing certainly influenced the outcome, however it's not clear that this was the best energy technology choice to push given its relatively high capital and O&M costs. While the institutional framework and financial mechanism were in place, it is not clear the business case was sound.

Country	Technology	Project Summary	Institutional Framework	Financial Mechanism	Capacity Building	Other Comments
Vietnam	Small wind power	Installation of 900 small wind installations of 150Wp.	RECTERE received government support to install rural household small wind installations.	90% of installations were grant supported, only 10% purchased directly. Cost for a 150 Wp system is about $270.	Installations maintained by technicians in the field and it is likely capacity buiding took place.	Given the cost profile and the high level of output compared to solar PV there appears a promising case for small wind in Vietnam. It would be worth understanding why greater market development has not yet taken place as Vietnam is reasonable wind potential.
Cambodia	Small wind power	Wind-powered water pump	Local NGO's one-off project (Cambodia Development Institute)	GEF grant support of $11k		Example of a one-off grant with no lasting impact.
Cambodia	Improved cookstoves	Cambodian Fuelwood Saving Project (CFSP). 1m ICS produced since production first began in 1996. Estimated 130,000 hhs currently use the stove	CFSP was collaboration of NGO Development and Appropriate Technology and Min of Industry, Mines and Energy, and supported by GERES. Now implemented through network of local distributors and retailers	ICS are 3x more expensive but also last 3 times longer. Payback in terms of fuel savings is 2 months. Microcredit has been set up for entrepreneurs participating in production and distribution with credit subsidized at 12% pa. Retail price is $3.50-4 and no credit needed for consumers.	Quality control and price regulation by ICoProDAC, local association	Firm support by Min of Industry coupled with an affordable financial mechanism has positioned this well for further scaling up and replication. Development of a network of local entrepreneurs to produce and distribute the stoves further enhances its sustainability prospects.

The Bigger Picture

Some of the case studies from the five countries of interest in this study provide examples of projects that failed to have sizeable or sustained impact. These cases of relative 'failure', can be attributed to a variety of specific factors, but in all cases there was no strong link to market mechanisms. In some instances, the level of subsidy required was too high for replication to occur in any significant way without substantial government or donor commitment. This was the case for the two micro-hydro case studies. In the case of solar PV efforts in Vietnam and Indonesia, the business and operational models for the projects were not sufficiently robust. In the two wind power case studies, little attention seems to have been paid to developing a pathway to commercial or semi-commercial dissemination.

The case studies also present several examples of projects that have achieved some degree of scale and that demonstrate the potential for continued sustainability. In all of these projects, local entrepreneurs and SMEs played a key role in providing continued technical and operational support to the delivery of rural energy services. These local private sector actors in many cases received training support to develop new skills and/or maintain technical standards. There is not one of the relative 'success' stories where the market was not an essential actor.

Another critical common element in all of the more successful cases was that one or more key innovation actors were central to the effort. In some instances these actors were supported by international NGOs, but the locus for learning and innovation was always locally based. For the successful delivery of locally appropriate energy services, localization and local innovation is essential. In an example from Lao PDR, a local non-profit group acted not as a direct provider of rural energy services but served as a focal point for research and capacity building for local-level renewable energy solutions, particularly around pico-hydro. It provided assistance to a variety of stakeholders, from poor rural householders to SMEs, regarding access to or provision of rural energy services. This group helped facilitate market mechanisms by providing learning and capacity building for a variety of stakeholders, ranging from consumers, other facilitating organizations, as well as providers.

Another vital element in the delivery of rural energy services is a credible local champion that gives rural consumers the confidence to try out new services. In some instances this can be a community group or local NGO, and in other cases, such as in the biogas programs in Vietnam and Cambodia, the local champions were the local offices of the respective Ministries of Agriculture. For a solar PV provider in

Lao PDR[39], the social enterprise itself was the primary national champion, but in the communities it was active in, the provider worked with the village community to have the community select members to serve on Village Energy Committee (VEC). It was the VEC which then became the provider's key local liaison to the community and one institutional arrangement was for the enterprise to rent equipment to the VEC which then was responsible for distributing energy services at the village level as well as collecting rents and other fees from individual households. Another institutional innovation by the same provider was to set up a franchise network of local technical service providers to maintain and install the various types of systems that were disseminated.

Another key element in the four case studies that achieved some level of scale was the involvement of the government. Government ministries were central actors in the biogas case studies, and also for the improved cookstove efforts in Cambodia. The one exception was Sunlabob, and while not part of the particular case study presented, in the past year a critical contract for Sunlabob was a project to equip local district offices with solar PV systems that resulted in revenues to Sunlabob of over $1m. This was key to their growth and Sunlabob is convinced that such public-private partnerships are critical for the scaled provision of rural energy services to poor populations.

Lastly, clearly having an appropriate financial mechanism is essential to facilitating access to energy services for the rural poor. Every potential technological solution to energy access requires some form of investment. For the rural poor whose incomes and expenses are typically balanced on a knife edge, having access to finance that enables investment is a great challenge. While the cost-benefit analysis of a possible energy option may indicate a favourable household or community energy investment, without access to financial mechanisms that enable that choice, even an optimal investment cannot be made. In every case that achieved scale, financial mechanisms enabled at least some portion of the target group to make those choices.

In summary, analysis of this compilation of SE Asian case studies informs a further iteration of Gitonga and Clemens' ideas with regards to key building blocks for innovation to be successfully disseminated. The areas they identify are indeed critical but some further specificity is also possible.

A strong institutional framework can cover a variety of institutional arrangements, but key elements within that framework can also be highlighted. First, part of that framework needs to include one or more key local innovation actors. This is a leadership organization that needs to be able to adapt lessons learned to local conditions as well as continue to innovate institutionally, technologically, financially

[39] Sunlabob, the provider referred to, provides other energy technologies besides PV solar but its longest history is with PV solar and it was its activities with regards to this technology that is the subject of the case study.

and socially as needs dictate. Support to this local innovating organization can come from international organisations, but it is critical that it is solidly grounded as well as physically located in the local context.

Besides an innovating organization, a local champion that lends credibility to new activities is also significant. This can be a government agency, a non-profit organization, a community organization or even a well-regarded local leader. The innovator is probably most often the initiator, but a local champion needs to provide their support for adoption to begin to take hold in a significant way. The local champion is also not only the advocate, but also the tangible link through which the innovating organization can be deeply/closely linked to the needs of the community it wishes to serve.

Lastly, with regards to a supportive institutional framework, public-private partnerships appear a vital form of institutional arrangement. Virtually every effort to provide rural energy services that has achieved some degree of sustained scale involves some variety of public-private partnership arrangement.

As emphasized earlier, ***an appropriate financial mechanism*** is the gatekeeper. For any rural innovation to have a chance to positively impact its target communities in a big way, base of the pyramid populations must be enabled to make the investments that are financially feasible. Appropriate and affordable technologies for rural energy provision in many instances have capital costs in the $200-500 range. Many poor households cannot afford this as a lump sum payment but can divert payments going forward, for instance for the purchase of alternative fuels like kerosene for lighting, to finance a microloan. In many cases arrangements with microfinance institutions provide the necessary mechanism for poor households to be directly enabled to purchase rural energy solutions such as biogas plants or solar home systems. In other cases a community group organizes community financing in the case of mini-grid approaches such as in the two micro-hydro projects, or alternatively leasing arrangements are made.

With regards to ***enabling policy aspects***, in several instances government played an active role to promote the delivery of new rural energy services. In the case of Project Access, which is promoting solar PV in the Philippines, the Department of Energy spearheaded this initiative and provided significant financial support as well as led efforts to engage the financial support of GEF. With the biogas programs in Vietnam and Cambodia, the respective Ministries of Agriculture took a similar key role, though this time in partnership with an international NGO. For improved cookstove efforts in Cambodia, the Ministry of Industry, Mines and Energy was deeply involved and also supported by both a local and international NGO. Where the government was not deeply involved it was at least important that barriers to rural energy service development were not erected. In the case of the micro-hydro project in Indonesia for example, the regulatory environment was such that the village was permitted to sell excess electricity back to the grid. It is notable that

significant government involvement was a characteristic of virtually all of the initiatives that achieved some level of scale.

With regards to ***functioning codes of practice***, these were very important in building public trust and contributing to strong word-of-mouth marketing that is so important in small rural communities. With the four case examples that achieved scale – namely biogas programmes in Vietnam and Cambodia, the improved cookstoves program in Cambodia and the solar PV provider in Laos – enforcement of strict quality standards was key. To achieve this, significant investments in training of local entrepreneurs to manufacture, install and maintain the various systems implemented were made, and where there were some problems in implementation and delivery of energy services, it was often the lack of reliable quality standards that was cited as a key impediment. With respect to pico-hydro in Laos, which is widely used and has spawned a robust local industry, quality standards vary considerably and establishing better standards is one of the key goals of the Laotian NGO LIRE.

Lastly, in all cases achieving scale, it was the ***active involvement of the private sector***, particularly local craftspeople and SMEs, and the development of a network of supporting small-scale businesses, that was responsible for the sustained and sustainable delivery of needed services. Only when market conditions are such that businesses can generate the profits needed to survive in order to participate over a sustained period in the rural energy value chain, can efforts towards the delivery of rural energy services persist and achieve scale and reach. In order for businesses to survive it must be the case that rural consumers sufficiently value the services provided and the enabling mechanisms are in place to permit such consumers to express this value. Subsidized efforts can be used to seed new service delivery, and there can situations where continued subsidy makes sense, but the bedrock of scaled, sustainable small-scale rural services delivery rests with decentralized, small-scale private sector players.

9. Concluding Remarks

Stepping back from the specific case examples and looking upon them as a group, the key, underlying observation is that for innovation, whether it be technological, institutional, policy-oriented or financial, to have a real, actualized impact on development, it must be embedded within market driven processes in order to achieve sustainability beyond the lifetime of a particular project. Considering pathways to dissemination is vital.

To achieve significant scale and replication, the simple but essential building blocks need to be in place: a strong institutional framework, whether government, private sector or NGO-led, and favoring some form of public-private partnership; an enabling policy environment, which could in some instances mean a policy environment that is

simply not obstructive, although truly supportive policies could spearhead energy service delivery; an appropriate financial mechanism, which can mean microfinance arrangements, co-operative community cost sharing arrangements or even simply an unfettered market; and finally functioning codes of practice that will earn and retain the faith of the market with the delivery of services of reliable standard.

In the arena of energy poverty, there is a dire need for innovation on all fronts, technological, institutional, policy-oriented and financial, and with so many possible pathways to addressing energy poverty, so many *opportunities* for innovation. It is imperative to focus that innovation effort in ways that will have a tangible benefit for the large numbers of the poor constrained by energy poverty.

10. Recommendations for ITS

The Recent History of ITS Programming in SE Asia Related to Energy

Through the small grants programs supported through two current projects, Science and Technology Innovation for the Base of the Pyramid in SE Asia (ITS project 104904), often referred to as iBoP Asia, and Enabling Bio-Innovation for Poverty Alleviation in Asia (ITS project 104530), ITS has already supported 8 grantees doing local level work related to energy, with each grant usually valued in the C$15-30,000 range. The subset of grants related to energy supported work in the following areas (unless otherwise noted, the grants were supported by iBOP Asia):

- Biofuels
    - Action for Economic Reform, Philippines – A study of the impacts of biofuel production on the poor in the that will also identify interventions or approaches to enhance benefits to BOP communities
    - SETARA[40] Foundation, Indonesia – Value chain analysis for aren/nypah biofuel and palm sugar production
    - Don Bosco Technical College, Philippines - A study of the feasibility of using waste cooking oil to fuel jeepneys
- Biogas
    - Ecological and Agricultural Development Foundation, Philippines – Pilot installation of biogas units, testing technologies, installation and financing arrangements
    - CEDAC, Vietnam[41] – Study of the social dimensions and institutional factors that enable and/or constrain a biogas program at the community level
- Solar

[40] Sejahtera Semestra Rakyat (SETARA) Foundation
[41] Supported by the Bio-Innovations project

    - University of Indonesia, Indonesia – The design and development of a solar powered hatchery machine that will help small poultry entrepreneurs increase their scale of production
- Wind power
    - TRICOM[42], Philippines – The design, development and analysis of low cost vertical axis wind turbines in Mindanao
- Improved cookstoves
    - UK Biochar Research Centre, fieldwork in India and Cambodia[43] – Stakeholder review of the potential for gasifier stoves and capacity building to promote wider deployment of biochar

The overarching goal of iBoP Asia was "to foster science and technology innovations that can effectively address the developmental needs of the poor and excluded". For the Bio-Innovations project, the overarching goal was "to stimulate and enable research on bio-innovation that is responsive to the development agenda of poverty alleviation in Indonesia, the Philippines, Thailand and Vietnam". Both efforts were interested in networking, with iBoP Asia networking a wide variety of stakeholders including small-scale farmers, small traders, development partners and the private sector, while the Bio-innovations project was particularly focused on the networking of researchers.

Most recently, in July 2010, ITS approved a $275k project focused on biofuel innovation, Towards Inclusive Biofuel Innovation in Indonesia (106159). This project aims to promote innovation capacity building related to biofuel development and use at the local level in two communities, the lessons learned from which will be used to promote policy learning to improve Indonesia's national biofuel program.

Recommendations for ITS

This paper provided a broad overview of issues around small-scale rural energy services for poor populations. It presented a high level geography of energy poverty as well as a household level snapshot of energy needs, laid out the spectrum of rural energy technologies, looked at a variety of successful and less successful case studies of attempts to provide rural energy services in SE Asia, and analysed these experiences using a framework from Gitonga and Clemens (2006) which was further elaborated. From this overview, some areas of interest for further research and engagement emerge:

1. ***Institutional innovation focusing on public-private partnerships.*** Institutional frameworks and institutional innovation are key to the successful delivery of rural energy services. Of particular interest is the potential for public-private partnerships to be a primary vehicle for sustainable, scalable,

[42] Tri-People Concern for Peace, Progress and Development of Mindanao (TRICOM)
[43] Supported by the Bio-Innovations project

market-based interventions, especially around goods and services deemed in the public good. While social enterprises can potentially deliver a variety of goods and services to base of the pyramid populations, with the exception of microfinance, these have tended not to achieve significant scale. For the provision of services in the public interest there is sound justification for public intervention, however private delivery systems may often be lower cost and more effective, suggesting a public-private model could be optimal. With the added global public interest at stake around climate change issues, green rural energy services are a particularly ripe area for public-private partnership with support from global institutional sources such as the World Bank and the GEF potentially available to partner with developing country government resources.

While the 'public' side of the partnership usually implies support in terms of resources, a particular focus of this work could be around the sensitivity to local needs provided by the partnership and in particular the role of local innovation in forming and shaping such partnerships. Top down government directives implemented by the private sector are likely not the highest potential approach. How can public-private initiatives listen closely to communities or even be driven by communities? This is where a local innovation actor may play a key role. What is an inclusive institutional model that extracts the best strengths of all parties and empowers the poor and their communities to have a strong influence on what needs are addressed and in what manner, and allows communities to play a key innovating role.

While the recommended set of activities below focuses on rural energy services provision, the findings would offer insight also regarding the provision of goods and services to BOP markets more generally. Given ITS's broader interest in BOP markets, this work could be a foundational building block for future BOP related work for ITS.

Some possible next steps and potential projects include:

- Meet and engage with several of the SE Asian groups discussed in this paper to get a deeper perspective. Notable groups of interest include SNV, Geres, Sunlabob, CEDAC, ETC, IBEKA, Project Access, E+Co and PRRM.
- Consider research that focuses specifically on public-private partnerships in small-scale rural energy services delivery. This could take a closer look at global success stories of such partnerships and draw out lessons learned. A particular focus of this work would be the prevalence and potential for inclusive innovation for and by the community or community-based groups. Case studies could look at global successes as in this study 'successful' SE Asian cases were limited.

- Another study (or the part of the same study) could also map out the potential for international support for such collaborations. The IGO and international NGO landscape around rural energy services is well populated, harbours significant resources and is complex. A better understanding of this landscape could be of considerable interest and usefulness to developing country governments and partners. Part of this study could also look at the implications for this landscape of recent climate change agreements.

2. ***Understanding the role of the local innovation actor and what enabling frameworks might facilitate their activities.*** Both the case studies and the landscaping overview in the appendix revealed a number of interesting local innovation actors. It would be interesting to explore further what are the building blocks for their success and what might be ways their work and even their emergence can be facilitated. In the case of LIRE, it was actually the social enterprise Sunlabob that supported its establishment. It would be useful to understand what key roles such an organization needs to play as a facilitator and innovator. Might a network of such players be useful for shared learnings and potentially shared policy influence?

   In addition to groups described in the case studies, many existing partners from previous and current ITS work would be included in this set of local innovation actors. Pursuing this strand further would be natural extension of ITS's existing portfolio of work.

   Some possible next steps and potential projects include:
   - Convene several of the groups mentioned above along with existing local innovation grantees and discuss key issues and areas of mutual interest. Jointly consider the potential value and activities of a network of local innovation actors.
   - Support research focused on the role of local innovation actors and the contextual elements which facilitate their emergence and strengthening.

3. ***Understanding policy constraints and enablers in the area of small-scale rural energy service provision.*** The interaction of local implementing and innovation players, government, policy and the socio-economic context are very country specific and in-depth country mapping could uncover insightful and impactful policy recommendations.

   Some possible next steps and potential projects include:
   - Conduct a cross-country comparison on the provision of rural energy services and critical policy provisions that enable or constrain the take up of rural energy services.

- Rather than taking on a large cross-country study immediately, having an in-depth look at one country would be instructive as well as a lower commitment way to address policy considerations. Within SE Asia, Cambodia could be an interesting study subject. The vast majority, nearly 80%, of its population is without access to electricity therefore despite its relatively modest population base is one of the countries with the largest population without electricity access in terms of absolute numbers. It is also a country where international development assistance plays a large role, key government decision makers are relatively known and accessible, and IDRC has already partnered with several government ministries and thus findings of this study would be well-placed to influence policy directly.

4. ***Exploring the potential for particularly promising technologies – small hydro, wind, and possibly solar.*** The economic costing estimates from ESMAP (2007) revealed promising small-scale technologies from a cost perspective, in particular small hydro and wind energy. While pico hydro in Lao PDR gave rise to a vibrant local market without particular external intervention, generally small hydro (including micro and mini hydro) appears a relatively unexploited opportunity. In the small hydro case studies for the Philippines and Indonesia, while the projects themselves were successful in achieving their goals, beyond the specific projects it was hard to see them scaling up in other locations in the same manner unless the considerable subsidy with which they were initiated was replicated. However the basic economics of small hydro would indicate there is considerable potential for the technology to be viable without large subsidy. It would of interest to investigate further what could enable a less subsidized model to find a foothold and replicate. The unexploited potential of other promising technologies could similarly be investigated.

   Some possible next steps and potential projects include:
   - Conduct research into small scale hydro projects to understand why there hasn't been greater take up. Could look for international success stories while taking an in-depth look at countries of considerable potential for the technology in SE Asia, the Philippines and Indonesia. Lao PDR could also be an interesting case for further investigation, and a cross-country comparison around this technology could also be of interest.
   - Conduct research into small scale wind energy in Vietnam and other places. The economics of the technology are promising but in SE Asia the technology has not found a foothold. Why is that and what could be done about it?
   - Conduct research into solar PV, which has a chequered history. What are the learnings from successful and failed solar PV programs. Why is it that

solar PV appears to be a technology that so many large government programs have tried to promote when the technology is relatively high cost and currently requires more ongoing maintenance in the form of replacement batteries as well as technical support than other small-scale technologies.

The above recommendations were a non-exhaustive list of potential avenues of exploration for ITS. Other program initiatives may also find related areas of interest. For example, GGP (Globalisation, Growth and Poverty) might be interested in the implications for the local economy of adopting small-scale as opposed to grid-connected energy solutions, and Ecohealth may have an interest in exploring the health implications of traditional cooking fuel use and the benefits of ICS and other technologies as well as exploring the role of social marketing in changing local practices.

As the scope of this study was desk-based research and did not include in-depth interaction with the groups or projects mentioned, it would be important to validate these recommendations with existing partners involved in energy as well as engage directly with some of the relevant agencies and organizations mentioned in this study as a key next step.

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Appendix: Interesting Groups Working on Energy Solutions in Asia

There are a great number of groups working on access to energy issues, and most of those groups are focusing also on clean energy technology. The set of actors described in the Appendix are but the tip of the iceberg, but should include many of the most active groups around these issues for SE Asia. While the focus of this paper was on smaller-scale innovations, many actors working at a larger, grid-connected scale were also included in the inventory of groups working on energy in Asia as they are an important part of the energy access landscape. As well, several groups work both with grid-connected and off-grid efforts.

Anticipating that the area of greatest interest is likely to reside in the local, or 'under the radar' innovation space, the group of actors of most interest might include the set of organizations cited in several of the case studies such as LIRE, Sunlabob, GERES, CEDAC, SME Renewables, SNV and YBUL amongst others, and also the promoters of smaller–scale and more private sector driven efforts such as PEI (Preferred Energy Incorporated), E+Co and REEEP. The WISIONS and Ashden Award models might also be worth a closer look regarding the effectiveness of grants competitions in furthering an innovation agenda. Regarding regional networks, the ADB's E4All Partnership is working at a smaller scale with a variety of partners and is in some ways an idea sink for the ADB's funding agenda with regards to the promotion smaller-scale energy solutions.

Networks

Regional

Energy for All Partnership (E4ALL) – http://www.energyforall.info/

The E4ALL Partnership is supported by the Asian Development Bank (ADB). The Partnership was formed specifically to build platforms for cooperation, exchange, innovation, and project development to address energy poverty. E4ALL brings together key stakeholders from business, finance, government, and the NGO sector to drive action. Their goal is to provide energy access to 100 million people in Asia and the Pacific Region by 2015. The focus of the partnership will be off-grid communities, whether rural, urban or peri-urban. Currently the partnership supports seven working groups in the areas of: solar lighting, biogas, liquid petroleum gas, financing, enterprise development, wind power and the Pacific Islands region. The working groups are self-directed with coordination provided by the E4ALL secretariat which is hosted by the Asian Development Bank (ADB). The Foundation for Development Cooperation, an Australian NGO, facilitates the Secretariat. Currently the Secretariat is funded at $700k for two years, and works closely with others in the ADB. Working groups can request some modest grant support from E4ALL, and can also apply to ADB for further support. E4ALL is the ADB's effort to support smaller off-grid approaches that complement the mid to large scale grid-related activity they also provide considerable support to. ADB does not seem to have designated a particular budgetary amount to projects that may arise through E4ALL but is keen to support interesting opportunities that may arise.

USAID Environmental Cooperation-Asia Clean Development and Climate Program (ECO-Asia CDCP) - http://www.cleanenergyasia.net

USAID launched the Environmental Cooperation-Asia Clean Development and Climate Program (ECO-Asia CDCP) in 2006 to help identify and promote clean energy solutions for Asia that address climate change and energy security. ECO-Asia CDCP partners national policy institutions, utilities, energy ministries, state-level governments, banks, investors, and clean energy project developers. Active in six countries – China, India, Indonesia, the Philippines, Thailand, and Vietnam – ECO-Asia CDCP works with these partners to catalyze policy and finance solutions for clean energy through targeted assistance, training, regional cooperation, and knowledge-sharing. The program serves as the secretariat to the Private Financing Advisory Network (PFAN, www.cti-pfan.net), and also spearheaded the establishment of the Asia Lighting Compact (ALC, www.asialighting.org). ECO-Asia's focus is

more catalyzing medium-large scale commercial clean energy activities rather than smaller-scale efforts. Along with the Asian Development Bank (ADB), ECO-Asia CDCP co-sponsors the Asia Clean Energy Forum which is probably the largest gathering of policymakers, experts and investors around clean energy concerns. Many interesting documents from the Forum can be found on the event website http://www.cleanenergyasia.net/events/asia-clean-energy-forum-2010-manila-philippines.

Energia-Asia – **http://www.energia-asia.org/home/**

Founded in 1996, ENERGIA is an international network of like-minded organizations and individuals, established to create an institutional base for galvanizing action aimed at integrating gender into the energy access agenda of developing countries. ENERGIA-Asia is the regional chapter of ENERGIA in Asia and works to mainstream gender into energy policies and programmes. They believe that when gender issues are explicitly addressed in energy policies and programmes, better outcomes will be achieved in terms of the sustainability of energy services as well as human development opportunities to both women and men. Energia-Asia's activities include capacity building, policy influence, networking, energy access and analysis. The Asia Region of ENERGIA includes nine countries, namely Bangladesh, India, Indonesia, Lao PDR, Nepal, Pakistan, the Philippines, Sri Lanka and Vietnam.

Energia-Asia launched the *Policy Innovation Forum on Networking Towards Gender and Poverty Sensitive Energy Policies* (http://energysolutionsforum.energia.org/index.html) in November 2008. The Forum is a joint initiative by ENERGIA, together with UNESCAP and brings together regional and national policymakers, and leading energy, poverty and gender specialists from government agencies, academia and non-governmental organisations in the region. The Policy Consultation and activities leading up to it were sponsored by the Directorate General for International Cooperation (DGIS), Netherlands, the Swedish International Development Cooperation Agency (SIDA) and ESCAP.

International

Renewable Energy and Energy Efficiency Partnership (REEEP) – www.reeep.org

REEEP is a global partnership that works to reduce the barriers limiting the uptake of renewable energy and energy efficiency technologies, with a primary focus on emerging markets and developing countries. Its interest appears to be to support small as well as large-scale green energy provision. REEEP engages in three main areas of activity: (i) it initiates and funds projects, targeting interventions in two specific areas that offer the greatest potential for developing the market for sustainable energy – assisting governments in creating favourable regulatory and policy frameworks, promoting innovative finance and business models to activate the private sector (ii) REEEP also develops and supports policy-maker networks through initiatives such as the Energy Efficiency Coalition (EEC), the Sustainable Energy Regulation Network (SERN) and Renewable Energy and International Law (REIL) sub-network, and (iii) REEEP disseminates and replicates learnings through news items, publications, its website and events. It also operates a search engine for the green energy world (www.reegle.info, co-developed with REN21) and a clean energy blog.

REEEP is supported primarily by developed country governments and by contributions from the private sector. REEEP has a network of Regional Secretariats, including the South-East Asia and Pacific Regional Secretariat which is hosted by the Australian Clean Energy Council and collaborates with national governments, financial and business professionals, and NGOs. Some projects supported in Asia include: development of a business model for village power in East Asia based on the village power experiences of China and Mongolia (2005-06), assisting potential project developers in the use of the Clean Development Mechanism (CDM) and other project finance mechanisms to support small-scale sustainable energy projects to deploy cookstoves and other clean technologies at the household and rural community level in India (2009-10), CDM study in China, Brazil, Philippines, co-funded with WWF, supporting the establishment of the Asia Sustainable Energy Fund (2005-06), development of a harmonisation roadmap for government procurement for energy efficient products through market and policy research (2007-08). Grants to support these projects were typically in the €100-300k range.

REN21 – Renewable Energy Network for the 21st Century – **http://www.ren21.net/**

REN21 convenes international multi-stakeholder leadership to enable a rapid global transition to renewable energy. REN21 promotes renewable energy to meet the needs of both industrialised and developing countries that are driven by climate change, energy security, development and poverty alleviation. The REN21 Secretariat is supported by UNEP and GTZ and is located in Paris. The overarching goal of REN21 is the promotion of policies that will increase the wise use of renewable energy worldwide. In order to achieve this objective, REN21 encourages action in three areas**:** Policy**,** Advocacy**,** and Exchange**.** Open to a wide variety of dedicated stakeholders, REN21 connects governments, international institutions, nongovernmental organizations, industry associations, and other partnerships and initiatives. REN21 leverages their successes and strengthens their influence for the rapid expansion of renewable energy worldwide.

GNESD – http://www.gnesd.org/

The Global Network on Energy for Sustainable Development (GNESD) is UNEP facilitated knowledge network of Centres of Excellence and network partners, known for their work on energy, development, and environment issues. GNESD has received financial support from the UN Foundation, UNDP and several Western governments. It is one of several Type II partnerships in the field of energy that were launched at the World Summit on Sustainable Development (WSSD) in Johannesburg, September, 2002. GNESD's Centers of Excellence in Asia are: Asian Institute of Technology (AIT), Thailand; The Energy and Resources Institute (TERI), India; Institute of Energy Economics (IEEJ), Japan.

Key objectives of GNESD's work include: strengthening members centres' ability to acquire and apply existing knowledge and experiences; working for a better understanding of the links between sustainable energy and other development and environment priorities, and technology and policy options, leading to better articulation of practical policies that can be adopted so as to promote and highlight the crucial role of energy for sustainable development; working to provide research findings to the Governments to be considered in formulating their policies and programmes; promoting a communication infrastructure that provides a means for Members to share experiences; strengthem South-South and North-South exchange of knowledge and collaboration on energy issues of common interest.

International Renewable Energy Agency (IRENA) – http://www.irena.org/home/index.aspx?mnu=hom

IRENA is a UN agency dedicated to facilitating the rapid development and deployment of renewable energy worldwide. Founded in 2009, it is the only UN agency wholly dedicated to the promotion of renewable energy. Prior to IRENA's establishment it was considered that such a dedicated multilateral agency for renewables has been conspicuously absent from the international landscape. 2010 will be its first operating year and it will have an initial annual operating budget of $12m. As of August 2010, 149 states had signed the IRENA statute. In SE Asia, the only signatories so far are Brunei Darrussalam, Cambodia, Malaysia and the Philippines. IRENA's Member States pledge to advance renewables in their own national policies and programs, and to promote, both domestically and through international cooperation, the transition to a sustainable and secure energy supply. IRENA is currently located in Bonn, Germany. It aims to become the leading international centre of excellence for renewable energy and a platform for exchange and development of renewable energy knowledge. It will provide advice and support to governments worldwide on renewable energy policy, capacity building, and technology transfer. IRENA will also improve the flow of financing and know-how and collaborate with existing renewable energy organizations. IRENA's goal is ultimately to increase the share of renewable energy worldwide.

The Global Bioenergy Partnership (GBEP) – **http://www.globalbioenergy.org/aboutgbep/en/**

Based at the FAO in Rome, GBEP was established to implement the commitments taken by the G8 in the 2005 Gleneagles Plan of Action to support "biomass and biofuels deployment, particularly in developing countries where biomass use is prevalent". Its purpose is to provide a mechanism for partners to organize, coordinate and implement targeted international research, development, demonstration and commercial activities related to production, delivery, conversion and use of

biomass for energy, with a focus on developing countries. promote global high-level policy dialogue on bioenergy and facilitate international cooperation, support national and regional bioenergy policy-making and market development, favour the transformation of biomass use towards more efficient and sustainable practices, foster exchange of information, skills and technologies through bilateral and multilateral collaboration, facilitate bioenergy integration into energy markets by tackling specific barriers in the supply chain, act as a cross-cutting initiative, working in synergy with other relevant activities, avoiding duplications.

GBEP works in synergy with other relevant initiatives, including among others: REN21, REEEP, FAO's BioEnergy and Food Security Criteria & Indicators project (BEFSCI), FAO's International Bioenergy Platform (IBEP), International Biofuels Forum, Methane to Markets, UNCTAD BioFuels Initiative.

Research Initiatives and Organisations

Regional/National

Laos Institute for Renewable Energy (LIRE) – http://www.lao-ire.org/

LIRE is a non-profit organisation dedicated to the sustainable development of a self-sufficient renewable energy sector in the Lao PDR. The institute offers agronomical, technological and socio-economic research services, and works to provide free public resources. LIRE strives to support the development of the country by exploring commercially-viable means to establish long-term alternatives to conventional practices. LIRE was founded in October 2006 by Lao companies, organisations and agencies with the common vision to establish a platform for renewable energy research in Lao PDR. The principal founding member of LIRE was Sunlabob Renewable Energy Ltd. Other founding members include the National University of Laos (Faculty of Engineering and Architecture), Technology Research Institute (TRI), and the Lao Renewable Energy Services Development Association (RESDA) among others.

Research activities in 2008 include: a jatropha research program, the development of solar-powered water purification systems with Sunlabob, evaluation of biomass gasification viability, biogas research programme with SNV, educational materials and technical research on pico hydro systems for widespread household use.

Research Center for Energy and Environment (RCEE Vietnam) – http://www.rcee.org.vn

RCEE does research and consulting in the field of new, renewable and clean energy and energy development and environmental protection. It works as a consultant for companies and organizations including foreign institutions on energy development and environment protection, especially on the field of renewable and clean energy development and energy efficiency. It also deals with climate change issues including issues around the Clean Development Mechanism (CDM), and developing CDM projects. RCEE also does training and educational activities. It is a network partner of EASE (Enabling Access to Sustainable Energy Partnership), who's description follows later in this document.

UNDP, Regional Climate Change, Energy and Ecosystems Project (RCCEEP) - http://regionalcentrebangkok.undp.or.th/practices/energy_env/rep-por/index.html

RCCEEP primarily focuses on enhancing equitable access to appropriate, reliable and affordable energy services to reduce human and income poverty. RCCEEP aims to contribute towards the achievement of MDG targets through broad-based interventions in three thematic areas of priority: improving access to energy services for the poor and underserved, promoting efficient use of energy focusing on MSMEs (micro, small and medium size enterprises), increasing access to financing for sustainable energy, including innovative mechanisms such as the CDM. The UNDP's Regional Energy Programme for Poverty Reduction (REP-PoR) which was implemented from 2005-2008 now appears subsumed into RCCEEP. Several case studies and other publications have been produced through this program. RCCEEP is run out of the UNDP's Asia-Pacific Regional Centre in Bangkok.

Asian Institute of Technology (AIT) - **http://www.ait.ac.th/**

AIT is based in Thailand, is an international postgraduate institution of higher learning with a mission to develop highly qualified and committed professionals who will play a leading role in the sustainable development of the Asian region and its integration into the global economy. AIT is organized into four schools, including the School of Environment, Resources and Development (SERD) which undertakes research and training on energy and the environment, i.e., renewable energy technologies, energy conservation, cleaner production, energy economics and planning, energy and environmental policies, power sector restructuring, environmental engineering and management, and climate change studies. (AIT has been the recipient of numerous IDRC grants and is an existing ITS grantee.)

The Energy and Resources Institute (TERI) – **http://www.teriin.org/**

TERI was established in 1974 and is located in New Delhi, India. While in the initial period the focus was mainly on documentation and information dissemination activities, research activities in the fields of energy, environment, and sustainable development were initiated towards the end of 1982.TERI is deeply committed to every aspect of sustainable development and is the largest developing-country institution working to move human society towards a sustainable future. Well on its way to becoming a cybercorp, TERI makes effective use of the latest developments in modern information technology in both its in-house and outreach activities. (TERI has been the recipient of numerous IDRC grants.)

RENDEV – http://www.rendev.org

RENDEV was a 3 year project exploring ways to link microfinance and access to renewable energy. The project aimed to make a positive contribution to rural development and poverty alleviation in Bangladesh and Indonesia by increasing access to solar energy, the development of micro enterprise, and the provision of microfinance mechanisms tailored for low income people's needs. The main objectives of the RENDEV project were: to promote development of income generating activities in renewable energy supply, to identify measures justifying involvement of SMEs in the solar energy sector, to build synergies between the microfinance sector, the renewable energy sector and microenterprises in Bangladesh and Indonesia, to better inform stakeholders providing pro-poor sustainable renewable energy services, to bring a positive impact on the quality of life in rural districts.

The project started in January 2007 and was scheduled to end in December 2009. The project was led by PlaNet Finance and project partners included Transenergie and IT Power Ltd. Local Indonesian partners were YBUL, Bina Swadaya, Optimal Power Indonesia. RENDEV is financed by the European Commission under its Intelligent Energy line.

International

Policy Innovation Systems for Clean Energy Security (PISCES) - http://www.pisces.or.ke/index.html

PISCES is a five year Research Programme Consortium funded by the U.K's Department for International Development (DFID). PISCES is working in partnerships in the UK, Kenya, India, Sri Lanka and Tanzania to develop new knowledge and policies promoting energy access and livelihoods through Bioenergy. The PISCES Consortium Advisory Group (CAG) made up of leading international participants in the field of energy and development including the IEA, UNEP, ENERGIA, DFID and FAO. Partner agencies include the University of Edinburgh, MS Swaminathan Research Foundation (MSSRF), Practical Action UK, East Africa and South Asia, and the University of Dar es Salaam.

The Small-Scale Bioenergy Initiatives Study (http://www.fao.org/docrep/011/aj991e/aj991e00.HTM) was developed jointly between PISCES and FAO addressing the common goal of improving understanding internationally regarding Small-Scale Bioenergy Initiatives and their impacts on rural livelihoods. Through the provision of brief descriptions and preliminary lessons on the livelihood impacts of a range of case studies in Asia, Latin America and Africa, it is hoped that some of the key challenges and opportunities of such initiatives may be better understood as a guide to future more detailed research, as well as ongoing and future initiatives in policy and practice.

International Energy Agency (IEA) – http://www.iea.org

The IEA is an intergovernmental agency which acts as energy policy advisor for its 28 member countries in their effort to ensure reliable, affordable and clean energy for their citizens. Founded during the oil crisis of 1973-74, its initial role was to coordinate measures in times of oil supply emergencies. Energy security remains a key priority, but has expanded beyond concerns about oil supplies to include natural gas and electricity. Current work focuses on diversification of energy sources, renewable energy, climate change policies, market reform, energy efficiency, development and deployment of clean energy technologies, energy technology collaboration and outreach to the rest of the world, especially major consumers and producers of energy like China, India, Russia and the OPEC countries. The IEA conducts a broad programme of energy research, data compilation, publications and public dissemination of the latest energy policy analysis and recommendations on good practices.

World Alliance for Decentralized Energy – http://www.localpower.org

WADE works to accelerate the worldwide development of high efficiency cogeneration, onsite power and decentralized renewable energy systems that deliver substantial economic and environmental benefits. It is a research and promotion organisation based in Edinburgh which conducts economic and policy research on all aspects of decentralized energy development in major emerging economies, through WADE Member Groups and the publication of WADE Market Analyses. WADE works in the areas of biomass, cogeneration, PV, wind energy and renewable energy generally. Its five key objectives are: to provide members and supporters with value added market intelligence, information and business opportunities; to bring about effective power sector reform which eliminates barriers to DE and creates real market opportunity for DE; to coordinate the creation and monetisation of high quality carbon credits from DE projects; to compile global data on all aspects of DE development; to support the establishment of DE groups in every country. In Asia, WADE is active in Indonesia and India.

Program Implementers/NGOs

Regional/National

Sunlabob – http://www.sunlabob.com/

Sunlabob is a Lao commercial company which operates as a profitable, full-service energy provider selling hardware and providing commercially viable energy services for remote areas. It is headquartered in Vientiane and engages in a variety activities including: provision of renewable energy hardware including: PV systems (PV panels, solar pumps, solar cooling systems), solar water systems, solar lanterns, high power LED lights, small hydro power systems, small wind turbines, biogas disgesters (piloting), and hybrid village grid systems that can combine hydro, wind, diesel, biofuel, biogas and solar energy to supply the village grid; training small rural entrepreneurs in installing and servicing energy technologies and act as franchisees of Sunlabob; acting as a rental company for solar systems working with a local rental company that collects rent and takes on a loan to purchase the systems, the village committee and local entrepreneurs who install and maintain the systems.

Since 2000, Sunlabob has installed over 5,600 systems in over 450 locations all over Laos. It has also teamed with other Lao agencies to launch the Lao Institute for Renewable Energy (LIRE). In 2008 it extended its activities to Thailand through its franchise partner Samui Servce Solarpower Ltd. While the focus in the Lao PDR is more on rural electrification, the market in Thailand is more focused on promoting solar water heating and energy efficiency consulting, both for homes and businesses. In 2009 Sunlabob introduced is Solar Lantern Programme to Uganda through its franchise partner Technical Specialist Services for rural Development (TSSD). It has formed PPPs with development agencies such as GTZ, DEG and IFC. Sunlabob has received numerous international awards including: 2009 National Energy Globe Award for Laos for the 3rd consecutive year, 2008 UNEP Sasakawa Prize, 2008 Lighting Africa winner together w African partner TSSD, 2007 Ashden Award winner for its Solar Lantern Project,

Cambodian Centre for Study and Development in Agriculture (CEDAC) – http://www.cedac.org.kh/home.asp

The Cambodian Center for Study and Development in Agriculture (CEDAC) was set up in August 1997 as a national Cambodian NGO, to develop sustainable agriculture and rural development in Cambodia in response to the country's desperate need for national reconstruction. CEDAC was created with initial support from the French non-government organization GRET (Group for Research and Exchange of Technology). As of August 2009, there were 431 staff, 87% of whom work as technical staff, providing direct assistance to about 100,000 families from 3,200 villages, 579 communes and 99 districts in 20 provinces of Cambodia. More than 100 organizations and agencies (community, national and internal organizations, foreign government agencies and multilateral organizations) have been cooperating with CEDAC during its 9 years of operation. Currently, CEDAC is considered as the biggest Cambodian Agriculture and Rural Development NGO. CEDAC was involved in the National Biodigester Progamme with SNV and the Ministry of Agriculture, Fisheries and Forests.

GERES Cambodia – http://www.geres.eu/en/geres-cambodia

GERES Cambodia has been working since 1994 to develop efficient energy solutions with the primary aims of conserving the environment and improving local communities' living conditions. In 2006, GERES Cambodia was the first project developer in the world to put forward an improved cooking stove project to trade on the carbon market. The "New Lao Stove", which saves a considerable quantity of charcoal in relation to traditional stoves and reduces CO2 emissions, will generate an average of 160,000 tonnes of carbon credits per year over a 10-year period (2003-2012). In 2008, GERES Cambodia undertook an important development programme on biomass energy with a view to validating sustainable models of energy supply and consumption. The 90-strong GERES Cambodia team offers various forms of consultancy services to companies and organizations in the fields of biomass management, reducing greenhouse gas emissions and carbon and energy audits, as well as research projects and studies on social and environmental topics.

GERES Cambodia is supported by its parent group, ***GERES*** (Groupe Energies Renouvelables, Environnement et Solidarités (Renewable Energies, Environment and Solidarity Group), www.geres.eu). GERES is a non-profit set up in 1976 following the first oil crisis and now has 180 associates carrying out innovative sustainable development projects in France and eight African and Asian countries.

SME Renewable Energy Ltd (SME-RE Ltd) – http://www.smerenewables.com/

SME-RE Ltd was established by SME Cambodia and E+Co as a new Cambodian renewable energy company. The new venture will promote renewable energy technologies and market biomass gasification power generation systems in Cambodia and throughout the Greater Mekong region. SME-RE Ltd. Offers turnkey projects, including system design, project feasibility studies, project planning and project financing, to rural electricity producers, agro-business processing enterprises and manufacturers requiring stand alone thermal or electrical energy solutions. Primary markets include rice mills, cashew processing plants, ice factories and noodle factories. Other potential customers are companies that currently depend on high cost diesel and other petroleum fuels for thermal steam generation, ceramic kiln firing and grain drying.

Approtech Asia (Asian Alliance of Appropriate Technology Practitioners) – http://www.approtech.org/

Approtech Asia was established in 1981, to increase the access of the poor to technologies and processes appropriate to their increasing needs and expanding capacities. Its primary role is to facilitate the sharing of appropriate technologies and cooperation among its member and partner-organizations. Alternative Energy Technologies is one of Approtech's several program areas. It promotes and exchanges energy technologies that will improve the lives of the poor. This includes technologies and social services related to improved cookstoves. Approtech Asia is the National Focal Point (NFP) of ENERGIA in the Philippines. Approtech facilitates the Approtech Asia Network

on Renewable Energy which has project work on rice husk gasifiers, improved cookstoves for households and micro-small industries, biogas technology and biofuel production. The Improved Cookstove Program of the Philippines (ICS-P) facilitates the transfer of technology on solar dryers for fish drying, herbals, fruits, etc. and rice-hull fruit dehydrators.

Asia Regional Cookstove Program (ARECOP) - http://arecop.org/index.php

ARECOP was initiated in 1991 as a network that facilitates the development of effective improved cookstove and biomass energy programs at the household and small industry levels. For more than a decade (ARECOP) has consistently focused its activities on the traditional wood/biomass energy using population, the millions of people who depend upon wood and other biomass as their main source of energy for their daily livelihood. Throughout the course of its mission, ARECOP activities have helped to shape the direction of improved cookstove programs in Asia. ARECOP has actively pursued the integration of improved cookstove program with other complementary developmental programs in order to enhance the spread of improved cookstove related activities in the absence of resources specifically dedicated to stove programs. In Asia, ARECOP has country contact points in Bangladesh, Cambodia, Indonesia, Nepal, the Philippines, Sri Lanka and Vietnam.

IBEKA (People Centred Economic and Business Institute) – http://ibeka.netsains.com/

IBEKA, is an NGO focusing on economics and energy issues in rural areas. IBEKA's main activities are: implementing rural electrification using renewable energy, building infrastructure for village development, research on the sources of renewable energy, project developers and trainers on mini and micro hydro activity. Since 1992, 40 micro hydro installations have been installed in the provinces of Aceh, West Sumatera, South Sulawesi, Nusa Tenggara Timur, South Sumatera and West Java, each with a capacity below 250kW. Each of these installations is managed and maintained by the Village Electricity Consumer Group or Village Cooperation Unit (KUD). IBEKA also conducts micro hydro power trainings for Indonesian groups as well as visitors from South and East Asia. IBEKA works in partnership with donors such as JICA, GTZ and UN-ESCAP.

Yayasan Bina Usaha Lingkungan (YBUL) – http://www.ybul.or.id

YBUL, established in 1993, is a non-profit organization based in Jakarta, specialized in promoting and implementing programs dealing with renewable energy, the CDM and community-based, environmentally friendly, SME empowerment through education, capacity building, feasibility studies and policy advocacy as well as access to microfinance and linking SMEs to technology, markets and financial access. YBUL's focus is particularly on rural communities and works on the following programs: community-based rural electrification, community empowerment, environmental financing mechanisms, green energy development. In the next five years, YBUL plans to promote community based rural electrification in 500 villages using various non-fossil energy resources such as solar, water and wind. To accelerate replication, YBUL will promote a community movement rather than a development project approach. Off-the-shelf packages of scientifically proven pico-hydro machines will be developed and promoted for communities who have the ability to afford them. Since 1996, YBUL has been the National Coordinator for the GEF Small Grants Program for Indonesia. YBUL's other partners include New Ventures Indonesia, WRI, Winrock International, IMIDAP (Integrated Micro-Hydro Development and Application Program), WWF, Yayasan Kehati (Indonesian Biodiversity Foundation). It is supported by 20 staff.

Bina Swadaya – http://www.binaswadaya.org

Bina Swadaya, (acronym of Badan Pengembangan Swadaya Masyarakat which means Community Self-Reliance Development Agency) is one of the biggest NGOs in Indonesia. It manages a number of services oriented towards the development of self-reliant communities. Its activities started in 1958, when the Pancasila Farmers Association (Ikaten Petani Pancasila, IPP) was founded. Bina Swadaya works to increase community self-reliance, particularly amongst the rural poor, based on the principles of openness, solidarity and social justice. Its strategy is to build the capacity of self-reliant groups in society, share information for development, develop constructive cooperation with government, NGOs

and the business world in and outside the country. Bina Swadaya has conducted many programs in cooperation with various stakeholders who care for the poor including: developing 650,00 community based groups for income generating activities (UPPKS) in collaboration with BKBN, developing 60,000 marginal fisherman groups in collaboration with Ministry of Agriculture, developing an Integrated Irrigation Program in collaboration with Ministry of Public Works.

International

SNV – http://www.snvworld.org/en/Pages/default.aspx

SNV is a non-profit, international development organisation, established in the Netherlands in 1965. It now operates in 35 countries in Africa, Asia, Latin America and the Balkans. It has 900 advisors in the field who come from a variety of cultural and technical backgrounds, and over 60 per cent are nationals of the countries where SNV works. The majority of SNV's advisors are based far from capital cities. From this sub-national level, SNV facilitates links between local and national organisations. SNV has an annual budget of over €100m. Most if this is financed by the Netherlands Ministry of Foreign Affairs. In SE Asia SNV is active in Cambodia, Laos and Vietnam.

More than half of SNV's work focuses on economic and private sector development. Alongside this, SNV contributes to improving people's access to basic services like water and sanitation, energy and education. SNV achieves both by strengthening local organisations. In the area of renewable energy SNV works on domestic biogas in Asia, East and Southern Africa, and West and Central Africa. In SE Asia work began in 2003 in Vietnam, 2006 in Cambodia, 2007 in Lao PDR and a pilot in 2009 in Indonesia. In Asia SNV estimates 300,000 households have been equipped with domestic biogas plants. SNV works in biofuels in six countries in Africa and Latin America, and in Asia it works on biofuels in Vietnam.

Enabling Access to Sustainable Energy Partnership (EASE) – http://www.ease-web.org/?page_id=2

The EASE partnership aims to bring modern energy products to the rural poor in developing countries, by facilitating the upscaling processes in the rural energy sector and local energy markets. EASE is a network of NGOs and visionary companies from Africa, Asia, Latin America and Europe, working on improving the structure and capacity of energy access markets for the poor. EASE projects start by better understanding the realities of the energy needs of the poor, and their local energy markets of shopkeepers, technicians, promoters and (micro) financiers. By presenting the bottlenecks in these local markets, EASE partners design and implement projects with a lasting impact.

EASE works in Latin America, Africa and SE Asia. ETC in the Netherlands acts as the member-facilitator and DGIS-Dutch Development Aid provides financial support. In SE Asia, EASE is active in Cambodia, Laos and Vietnam and network partners include GERES, Laos LIRE, Sunlabob, RCEE, EASE Vietnam, CCRD, PED.

Ashden Awards – http://www.ashdenawards.org/

The Ashden Awards highlight inspiring sustainable energy solutions in the UK and developing world and help disseminate these experiences and practices more widely. Since its inception in 2001 the Ashden Awards have helped more than 100 innovative projects develop their work. Today the Awards are an internationally recognised yardstick for excellence in the field of sustainable energy. The awards are part of a broader process — sharing knowledge, passing on experience and offering advice and support. Throughout the year Ashden Award winners are held up as examples of green energy in practice. They are brought to a wider audience through the international media, seminars and presentations and introduced to influential people and organisations to help change their thinking and policy.

WISIONS – http://www.wisions.net/

WISIONS is an initiative of the Wuppertal Institute. The core team is made up of members of Research Group 1 "Future Energy and Mobility Structures" of the Wuppertal Institute. WISIONS is

also backed by the experience and wide range of knowledge of other colleagues within and outside the institutes. Since 2004 WISIONS conducted five rounds of Sustainable Energy Project Support (SEPS. SEPS has become a well-established support scheme for sound, sustainable energy projects. A total of 47 SEPS projects have so far been selected for support. They cover a wide range of innovative sustainable energy solutions in some 36 countries in Latin America, Africa and Asia. For 2010 the total grant support provided is €350k and will be distributed amongst 8-10 selected projects. Typical grant sizes are in the €30k-60k range.

Winrock International - http://www.winrock.org/

Winrock International is a nonprofit organization that works with people in the United States and around the world to empower the disadvantaged, increase economic opportunity, and sustain natural resources. Winrock matches innovative approaches in agriculture, natural resources management, clean energy, and leadership development with the unique needs of its partners. By linking local individuals and communities with new ideas and technology, Winrock is increasing long-term productivity, equity, and responsible resource management to benefit the poor and disadvantaged of the world. In the area of energy, Winrock is involved in project design and implementation, training and institutional capacity building, grant management, policy analysis, financing facilitation, energy resource assessment and capabilities gender integration. In SE Asia, Winrock is active in the Cambodia, East Timor, Indonesia, Lao PDR, Malaysia, Philippines, Singapore, Thailand, and Vietnam.

International Institute for Energy Conservation (IIEC) – http://www.iiec.org/

IIEC is a non-governmental (NGO), not-for-profit organization with offices in Africa, Asia, Europe, Latin America, and North America. It was established in 1984 to foster the implementation of energy efficiency in developing countries and countries in transition. Through its global network of eight offices, IIEC partners with both public and private sectors, NGOs, community groups, universities and other stakeholders to develop, implement, and evaluate energy-efficiency policies, programs, and projects. The activities are often multi-disciplined in nature, requiring interactions between professionals at the federal, state, and local governments in partnership with industry. Specific services that IIEC provides to its clients include end-use energy efficiency, energy efficiency standards and labeling, renewable energy, energy efficiency finance design, environmental management, water resource management, climate change and energy policy and transport planning. In Asia, IIEC has offices in Bangkok, Manila and New Delhi.

Practical Action - http://practicalaction.org/

Practical Action was founded in 1966, as ITDG (the Intermediate Technology Development Group), by the radical economist Dr EF Schumacher to prove that his philosophy of 'Small is Beautiful' could bring real and sustainable improvements to people's lives. Practical Action works in four key areas: reducing vulnerability, making markets work for the poor and helping poor communities access new technologies that can improve their lives. In its international work Practical Action demonstrates alternatives, shares knowledge and influences change through advocacy, provision of freely available technical information, support services to teachers on sustainable development, and through its consulting and publishing activities. Currently Practical Action works in Peru, Kenya, Sudan, Zimbabwe, Sri Lanka, Bangladesh and Nepal. Practical Action materials are useful resources for community based groups.

ETC – http://www.etc-international.org/

ETC is a Netherlands headquartered international development agency which receives funding support from a range of donors including the Netherlands Ministry of Foreign Affairs. It also raises funds through client services it delivers and has 75 staff. ETC devotes about half of its resources to support change through capacity development in civil society, governmental institutions and the private sector. Local partners are responsible for direct poverty alleviation but ETC also supports projects involving innovation and learning. The areas ETC works in include health, endogenous development, energy and gender, energy and poverty, climate change, natural resource management, sustainable agriculture, biodiversity, urban agriculture and food security, rural development.

Financial and enterprise support organizations

Regional/National

Preferred Energy Incorporated (PEI) - http://www.pei.net.ph/index.htm

PEI is a non-profit organization that initiates and supports development efforts and investments in renewable energy and other clean development projects in the Philippines. To this end, PEI provides a full range of financial, technical and policy advisory services and assistance to both public and private sectors in these fields of endeavor. It provides an integrated, multidisciplinary approach to the development of projects, nurturing each project - from inception to operations - to ensure its success. PEI also networks with government agencies in policy and project implementation matters; works closely with financial institutions to improve investment climate for renewable energy projects; and networks with foreign trade associations to promote opportunities for global trade.
PEI works with commercial as well non-profit partners local and international partners. It is the SE Asia focal point for REEEP (also written up), and also manages USAID-Winrock International's Renewable Energy Financing and Technical Assistance (REFTA) Capital Investment Fund. The fund was capitalized at $700k and catalyzed 3 projects, Bubunawan 7-MW mini-hydro project; Villa Escudero 98-kW micro-hydro project; and Solar Electric Company PV Dissemination project. These projects eventually secured nearly $11m in total investment and are just a subset of a variety of projects that include wind, biogas, micro-hydro.

International

E+Co - http://eandco.net/

E+Co makes debt and equity clean energy investments in developing countries. The investments range from approximately $25k to $1m, and current average investment size is about $150k. E+Co's strategy is to invest start up and growth capital in small and growing energy businesses that fall in the "missing middle" – the space between microfinance and traditional commercial lending. While these businesses play a pivotal role in the growth of developing country's economies generally and the clean energy sector more specifically, they often are unable to access the financing they need to sustain their operations. E+Co's strategy is to invest the capital needed to grow clean energy businesses and provide the business support needed to mitigate the risk of default. Through its portfolio investments of $40m to the end of 2009, E+Co has leveraged $253m of additional capital, assisted to provide 6.2m people with access to clean energy, improved incomes by $7m, generated carbon offsets of 4.6m and earned a portfolio return of 8.7%. Currently it has 268 investments, 237 of which are debt and the remainder equity. By 2012 E+Co intends to make another 300 investments serving more than 20m people with access to clean energy by investing $190m and leveraging an additional $900m.

E+Co partners and supporters include: Citigroup Foundation, GTZ, IFC, Oxfam Novib, REEEP, UNEP, USAID, Gates Foundation, John D and Catherine T MacArthur Foundation, IADB, Packard Foundation, Rockefeller Foundation. E+Co has been operating for 15 years and has offices in 8 locations – China, Costa Rica, Ghana, South Africa, Tanzania, Thailand, The Netherlands and the United States. In Asia, E+Co has investments in Cambodia, China, India, Philippines, Thailand and Vietnam. (SME Renewable Energy Ltd, the Cambodian biomass case study, is and E+Co investment.)

Global Village Energy Partnership (GVEP International) – http://www.gvepinternational.org/

GVEP International is an international non-profit organisation seeking to reduce poverty through accelerated-access to modern energy services. GVEP believes that business-led solutions are essential to meet the energy needs of people living in developing countries. Its mission is to promote social and economic development in rural and peri-urban areas of developing countries by increasing access to appropriate modern energy services. It does this by providing start-up and growth capital to early-stage energy SMEs in selected countries in Latin America and Africa. Its programmes, which deploy grant funding and equity investments, allow donors and social impact investors to support energy entrepreneurs whose ventures are constrained by limited access to capital. GVEP typically combines financial support with technical advice and business coaching. It is currently active in Latin

America, Africa and India. To date GVEP International has supported over 300 active microenterprises under the Developing Energy Enterprises Programme (DEEP) in East Africa. In Latin America it has 7 business ideas in incubation, 7 startups, 1 SME in the expansion phase, and another moving to a diversification phase. GVEP International's partners include: IADB, GTZ, the World Bank, DFID, USAID, DGIS (Dutch government), EU, Garfield Weston Foundation, Ashden Foundation, Barclays Bank,

Some GVEP activities include: Energy for India's Poor Challenge, partnering with ennovent[44] to provide $500k to a successful business idea targeting the poor with modern energy services; working with the Applied Environmental Research Foundation (AERF) in rural India to increase the numbers of villages producing and using biofuels; Ideas Energy Innovation Contest[45], a grant competition launched in 2009 to turn ideas to support the promotion of renewal energy into viable businesses through which 26 winners each received a two-year development grant of up to $200k (a new contest is going to be launched in June 2011); a policy coordination platform in Peru to be launched in 2011, GVEP will work with a wide range of stakeholders, including government, private companies, NGOs and academic institutions together in a common platform that will provide a forum for multi-sectoral coordination; DEEP, set up in 2008 and planned to operate for 5 years, the programme aims to provide modern energy services and products to 1.8 million people in rural and peri-urban areas in the Kenya, Uganda and Tanzania by developing a sustainable and widespread industry by supporting 1,800 micro and small energy enterprises.

InfoDev Climate Technology Program – **http://www.infodev.org/en/Topic.19.html**

Launched in July 2009 as a collaborative effort between the World Bank's Information for Development Program (*info*Dev) and the UK Department for International Development (DFID), the goal of this program is to "accelerate the development and deployment and transfer of emerging clean technologies in middle and low-income countries". While precise funding figures were not available, it would appear a very generously funded effort. It will begin with the establishment of three Climate Innovation Centres, and it is envisioned that after piloting the centres, up to 10 centres could eventually be opened around the world. In an early white paper making the case for these centres, it was estimated that annual running costs for each centre would be in the $40m-$100m range. Two centres are in the planning phase, in India and in Kenya, the business plans for which will be finalized July-Sept 2010. For Asia, it would appear that eventually 3 centres are envisioned. Besides the one in India, they appear targeted for Indonesia and Vietnam, with planning to begin for the Vietnam CIC currently under 'investigation'.

The centres aim to address the following activities, which will provide a continuum of support from the early stages of technology demonstration to full market deployment: applied research and development, technology acceleration including field trials, business incubator services, enterprise creation, early stage funding for low carbon ventures, financial and advisory support for the deployment of existing energy efficiency technologies, capacity building support, policy analysis and insight.

Related organizations include:

The Carbon Trust **(**http://www.carbontrust.co.uk/Pages/Default.aspx**)** – Funded by the UK's Department of Environment, the Carbon Trust is one of proposers of Climate Innovation Centres for the developing world. It has performed in a similar capacity in the UK since 2001. "The Carbon Trust is a not-for-profit company with the mission to accelerate the move to a low carbon economy. We provide specialist support to help business and the public sector cut carbon emissions, save energy and commercialise low carbon technologies."

[44] ennovent is a social venture capital firm focused on supporting sustainable solutions for base of the pyramid populations in India (http://www.ennovent.com/en/home.html).

[45] Many of the ideas funded sounded very much like the grants supported by iBoP, some examples include: fuel and electricity from tyre recycling in Columbia, high efficiency water wheels in Peru, bioethanol from waste milk whey in Chile.

infoDev **(**www.infoDev.org**)** – infoDev is a multi-donor sponsored program that explores the link between technology and development. It is housed at the World Bank in Washington DC. infoDev manages a global network which includes over 300 business incubators in more than 80 developing countries. In its 8 years, this network has assisted more than 20,000 companies and helped create over 220,000 jobs worldwide. infoDev's key value-add is building global entrepreneurial and SME communities of practice through its network to share and disseminate best practices and facilitate collaboration.

World Bank Asia Alternative Energy Program (ASTAE) - http://www.worldbank.org/astae/

ASTAE was established to mainstream alternative energy (renewable energy and energy efficiency) in the World Bank's power sector lending operations in Asia. It offers assistance in the identification and preparation of renewable energy and energy efficiency/demand-side management (DSM) projects for World Bank/Global Environment Facility (GEF)-supported operations in Asia. These combined operations have had very significant impacts in quantitative terms – over the past 16 years, close to 2 million households have gained access to electricity, over 1GW of renewable energy generation capacity has been installed in the region, energy efficiency gains have replaced 1GW of generating capacity equivalent, and total carbon dioxide emissions were reduced by over 200 million tons. The ASTAE contributions alone did not achieve these big gains, but they constituted an essential catalyst for the effective scaling-up of World Bank lending operations. ASTAE's current mandate rests on four pillars, improving energy efficiency, scaling-up the use of renewable energy, increasing access to energy to reduce poverty, and promoting adaptation to potential impact of climate change. Experience from all four pillars of ASTAE support, show the consolidation of three essential functions of ASTAE (i) introduction of innovative investment delivery mechanisms (ii) the development of institutional regulatory frameworks (iii) training and knowledge sharing. In SE Asia, ASTAE works in Cambodia, Indonesia, Laos, Malaysia, Philippines, Thailand and Vietnam.

World Bank Energy Sector Management Assistance Programme (ESMAP) – http://wbln0018.worldbank.org/esmap/site.nsf

ESMAP is a global technical assistance trust fund which helps build consensus and provides policy advice on sustainable energy development to governments of low- and middle-income countries. ESMAP also contributes to the transfer of technology and knowledge in energy sector management and the delivery of modern energy services to the poor. Currently ESMAP focuses on three core functions: influencing policymaking and broadening knowledge through analytical and advisory services; sharing tools, best practices and lessons learned through training events and knowledge exchange activities; providing 'just-in-time' technical assistance to implement policies and strategies. In SE Asia, ESMAP works in Cambodia, Philippines, Thailand and Vietnam. Around the world it is active in South Asia, Latin America, Eastern Europe, South and North Asia and Africa.

Scaling up Renewable Energy in Low Income Countries (SREP) - http://www.climateinvestmentfunds.org/cif/srep

The Program on Scaling-Up Renewable Energy in Low Income Countries (SREP) is a targeted program of the Strategic Climate Fund (SCF), which is within the framework of the Climate Investment Funds (CIF). It is complementary to the CIF Clean Technology Fund (CTF), which focuses on middle income countries. All funds are channeled through the regional development banks (i.e. Asian Development Bank (ADB) and others) and the World Bank Group agencies. It aims to help low-income countries use new economic opportunities to increase energy access through renewable energy use. The SREP stimulates economic growth through the scaled-up development of renewable energy solutions and, it acts as a catalyst for the transformation of the renewables market by obtaining government support for market creation, private sector implementation, and productive energy use. SREP is country-led and builds on national policies and the activities of other existing energy initiatives. It will operate in a small number of low-income countries to maximize its impact and demonstrative effect. In SE Asia, the countries that qualify for support are Cambodia, Laos, Timor-Leste and Vietnam. In 2010, Ethiopia, Honduras, Kenya, Maldives, Mali and Nepal were chosen as pilot countries for SREP.

GEF Small Grants Program (GEF SGP) – http://sgp.undp.org/

For nearly 20 years, the GEF SGP has been working with communities around the world to combat the most critical environmental problems. With presence in 122 countries and more than 12,000 grants awarded worldwide, SGP supports projects of non-governmental and community-based organizations in developing countries. The main focal areas of the programme are climate change abatement and adaptation**,** conservation of biodiversity, protection of international waters**,** reduction of the impact of persistent organic pollutants and prevention of land degradation. To date the program funding from the GEF is approximately US$401 million. In addition, the program has raised US$407 million from other partners in cash or in-kind equivalents. Grants are made directly to community-based organizations (CBOs) and non-governmental organizations (NGOs) in recognition of the key role they play as a resource and constituency for environment and development concerns. The maximum grant amount per project is US$50,000, but averages around US$20,000. Grants are channeled directly to CBOs and NGOs. In SE Asia, GEF SGP is active in Cambodia, Indonesia, Malaysia, the Philippines, Thailand and Vietnam.